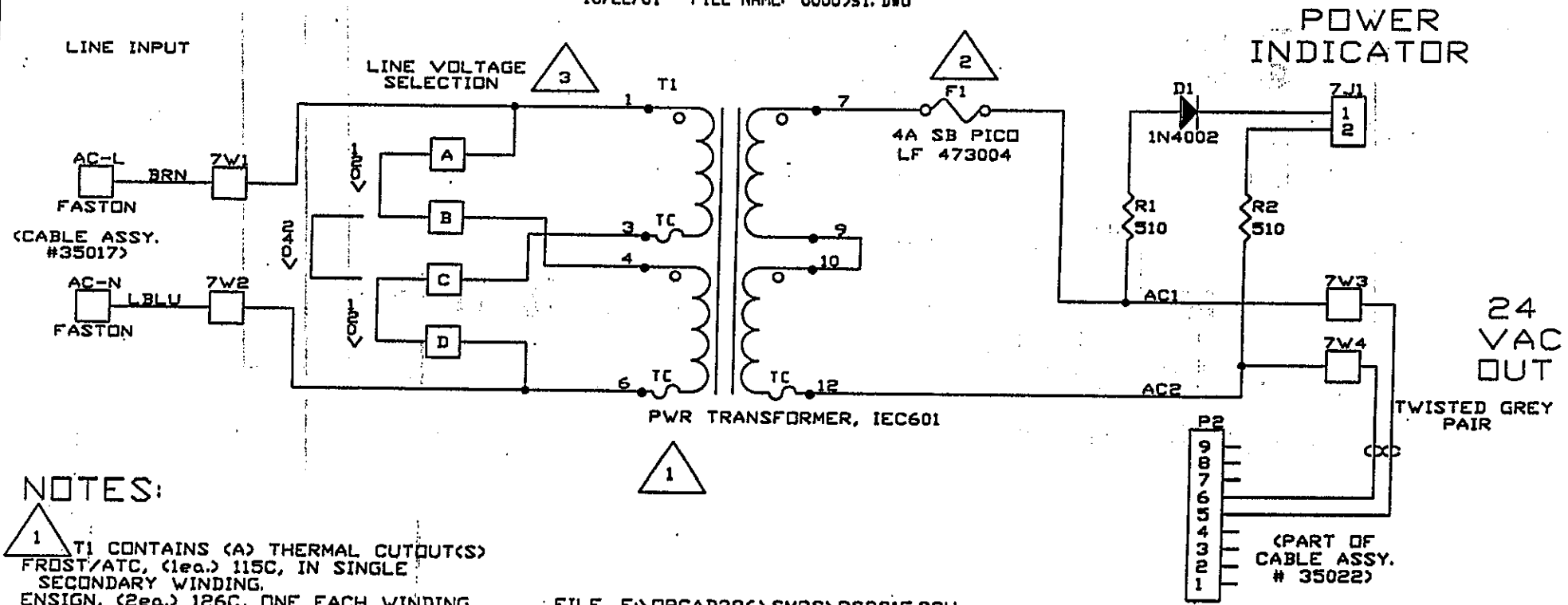
Figure 2.3.0

TRANSFORMER PCB SCHEMATIC

SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 60009s1.DWG



NOTES:

1. T1 CONTAINS (A) THERMAL CUTOUT(S) FROST/ATC, (1ea.) 115C, IN SINGLE SECONDARY WINDING. ENSIGN, (2ea.) 126C, ONE EACH WINDING OF DUAL PRIMARY.
2. F1 MUST BE REPLACED WITH A 4-AMP SLOW BLOW FUSE LITTELFUSE 473004 PICO FUSE OR EQUIVALENT.
3. LINE VOLTAGE SELECTION: 120V: A-B, C-D JUMPERS (STANDARD). 240V: B-C JUMPER (CUT JUMPER TRACES AT A-B, C-D).

FILE E:\ORCAD386\SMPS\PS2S1F.SCH

DRAWN: HUFNAGEL 12/03/93 T. UNDERWOOD 7-8-96 D. PEGG 7-3-96 C. MARTINA 7-9-96 R. BRANDT 7-9-96	SIGMA International Inc. 711 PARK AVENUE MEDINA NY 14103-0756 TEL:(716)798-3901 FAX:(716)798-3909
	TRANSFORMER BOARD, MODEL 8000
December 28, 1995	SIZE A | CAGE CODE | DWG NO 60009 | REV F
	SCALE | SHEET 1 OF 2

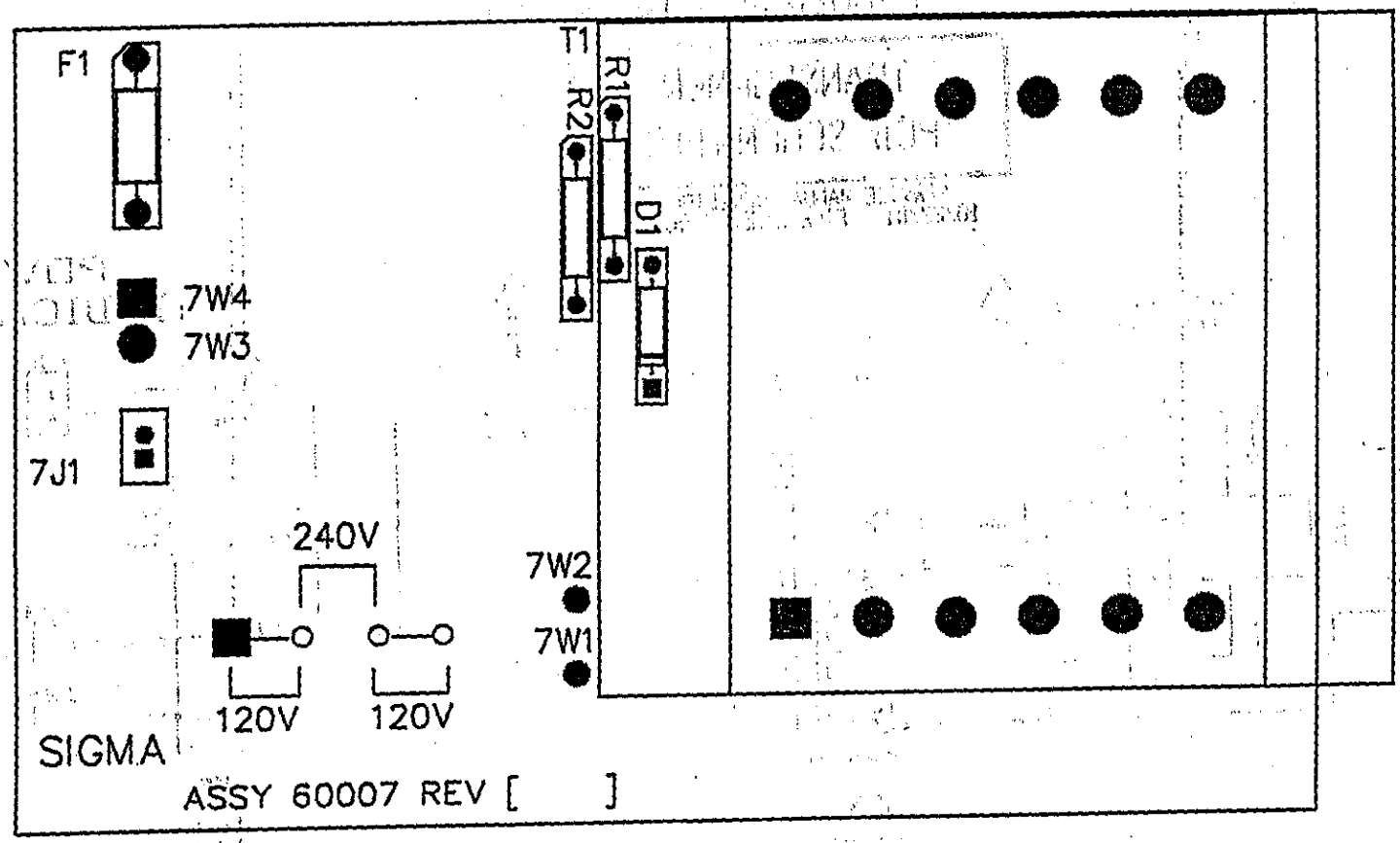


Figure 2.3.1

TRANSFORMER
PCB ASSEMBLY

SERVICE MANUAL RE. .ION E
10/22/01 FILE N. 60007.DWG

TABLE 2.3.2 Revision: E

TRANSFORMER PCB, MODEL 8000

Bill Of Materials

Item	Quant.	P/N	Ref.	Description/Manufacturer
1.	1	70161	D1	1N4002 TH
2.	1	25302	F1	4A SB PICO TH
3.	1	60008	PCB	PCB, TRANSFORMER
4.	2	16024	R1,R2	RESISTOR, 510 OHM, 1/4 W, 5% TH
5.	1	55001	T1	PWR TRANSFORMER, IEC601 TH
6.	1	30002	7J1	HEADER,2-PIN,V,2mm pc hdr TH
7.				
8.	REF	35022	CBL2	POWER SUPPLY CABLE
9.	REF	35017	CLB3	WIRE HARENESS

Replace T1 only with the transformer above. Substitution violates the Certification of this product and may compromise product safety.

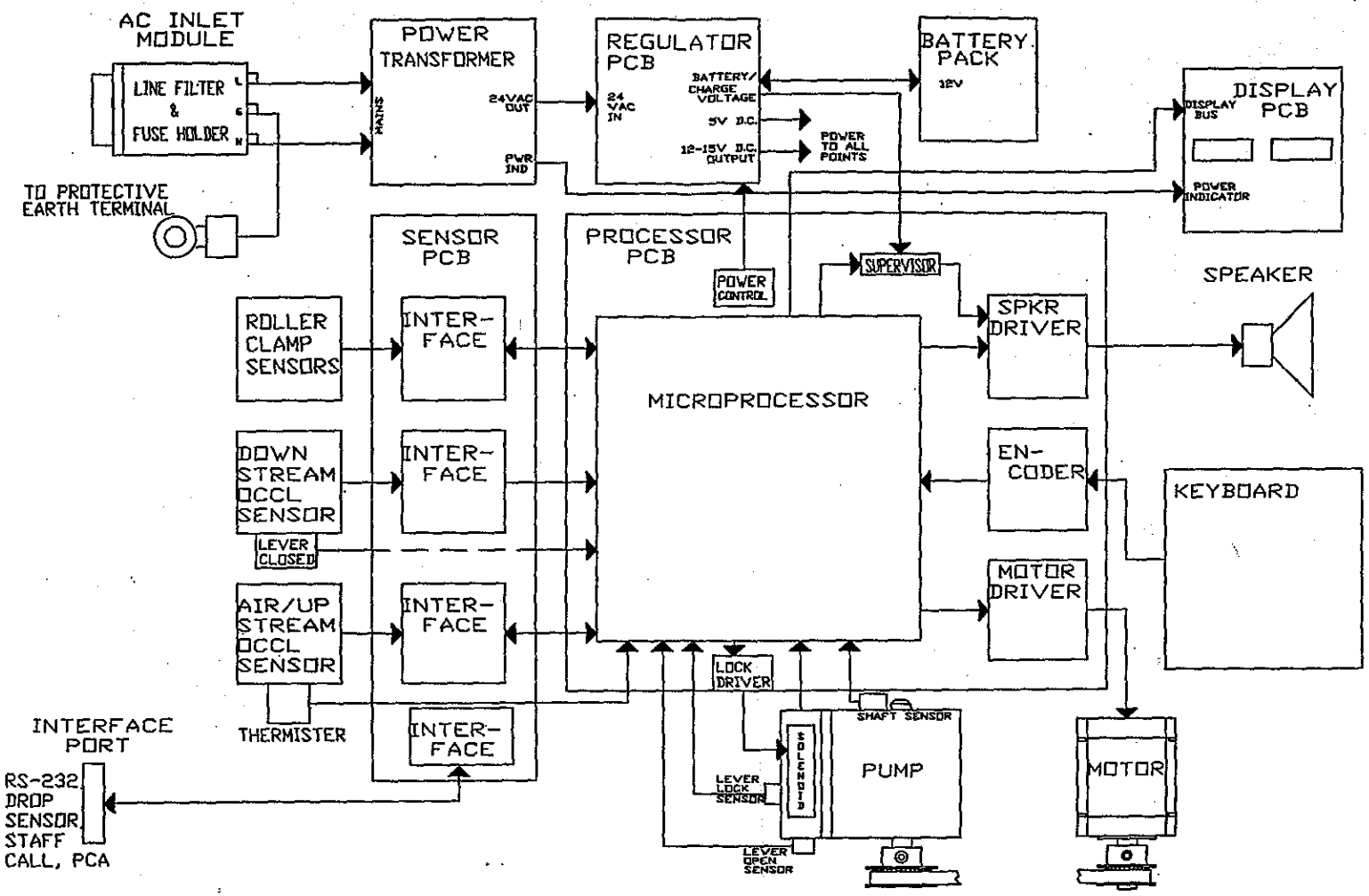


Figure 2.1.0

BLOCK DIAGRAM

SERVICE MANUAL REVISION E
10/22/01 FILE NAME: BLKDIAGC.DWG

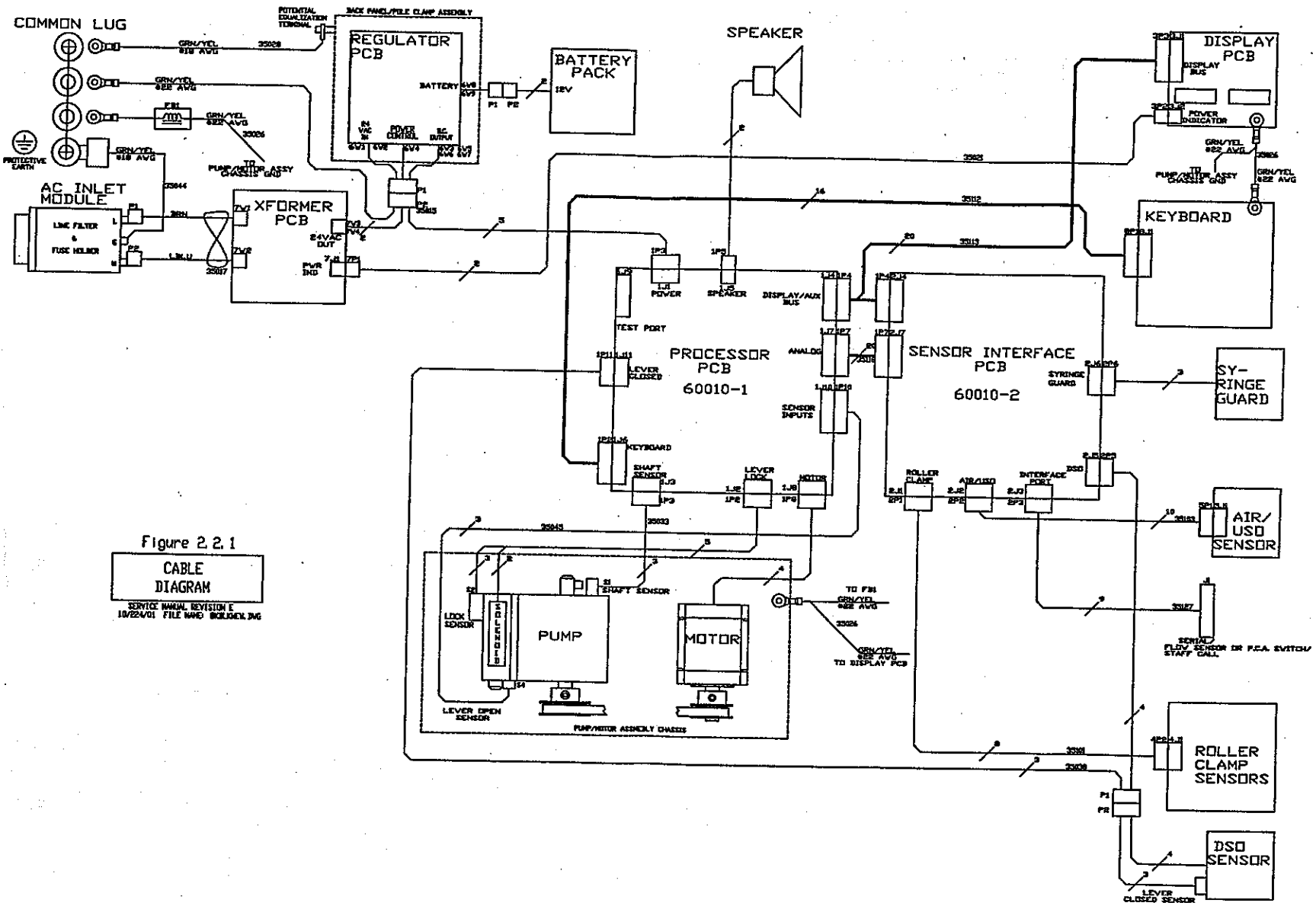


Figure 2.2.1

CABLE DIAGRAM

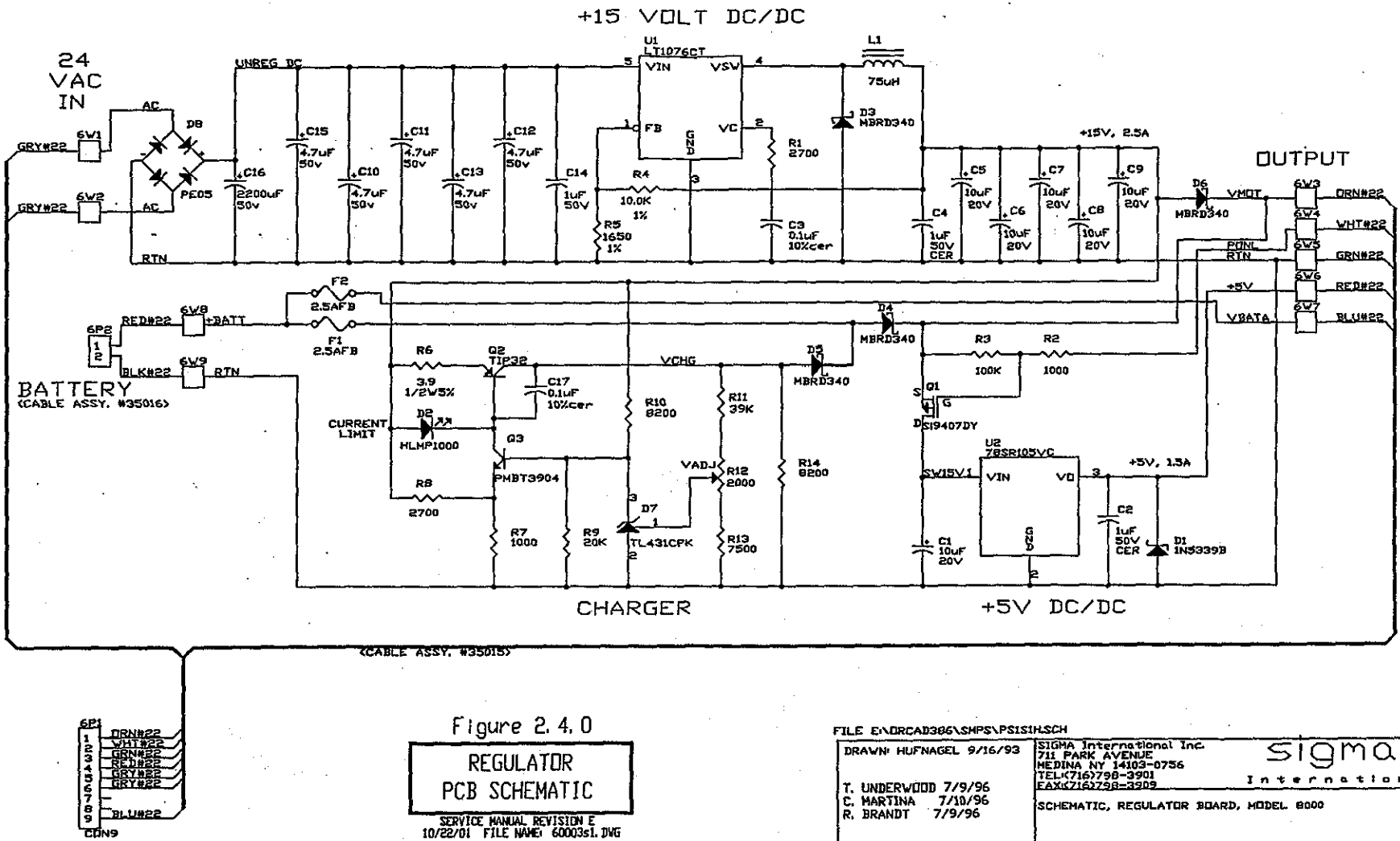


Figure 2.4.0

REGULATOR PCB SCHEMATIC

SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 60003s1.DWG

FILE E:\ORCAD386\SMPS\PSIS1H.SCH

DRAWN: HUFNAGEL 9/16/93	SIGMA International Inc. 711 PARK AVENUE MEDINA NY 14103-0756 TEL:(716)798-3901 FAX:(716)798-3909	sigma International	
T. UNDERWOOD 7/9/96 C. MARTINA 7/10/96 R. BRANDT 7/9/96	SCHEMATIC, REGULATOR BOARD, MODEL 8000		
	SIZE B	CAGE CODE	DWG NO 60003	REV H
February 9, 1996	SCALE		SHEET 1 OF 2	

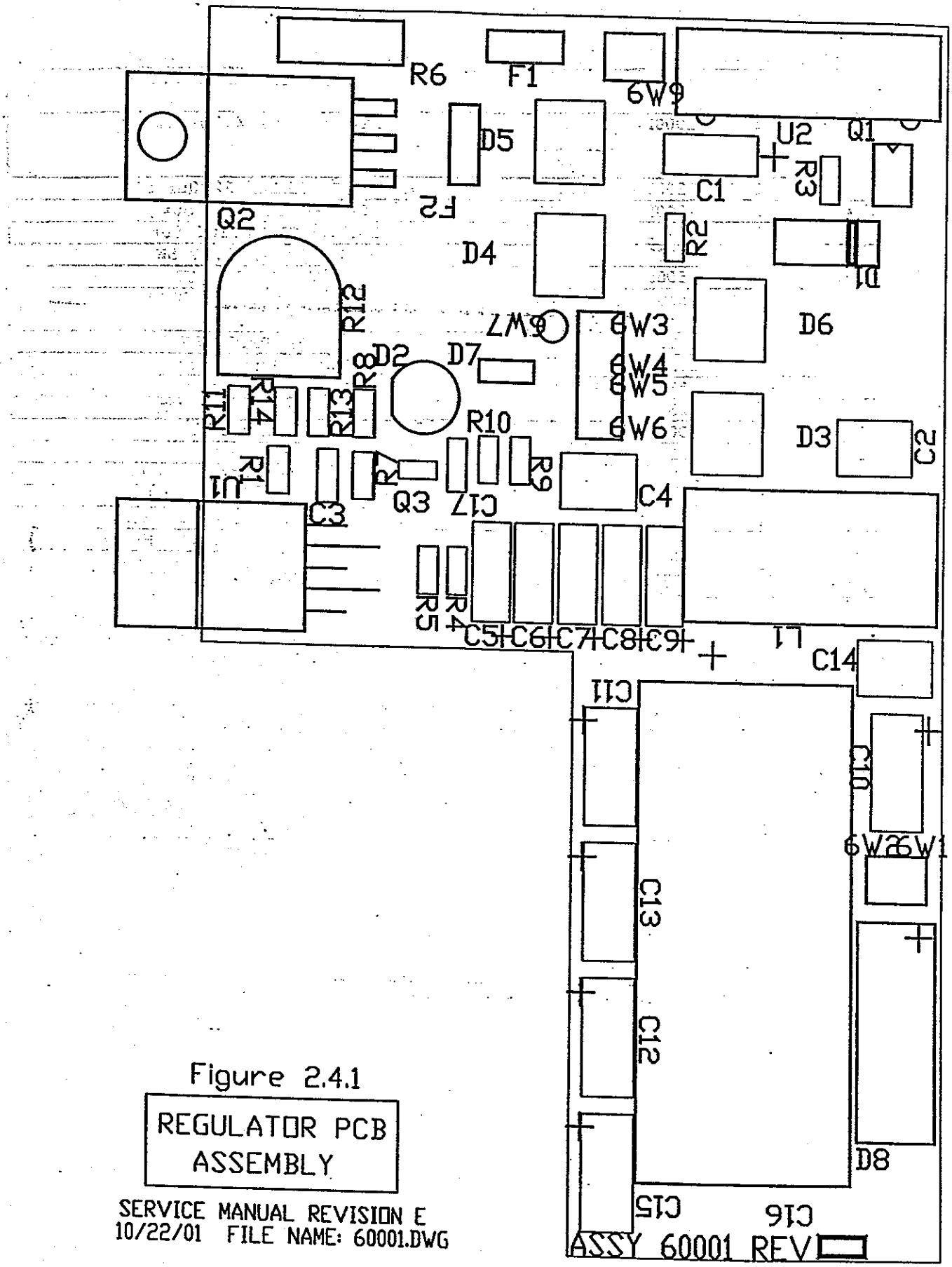


Figure 2.4.1

REGULATOR PCB ASSEMBLY

SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 60001.DWG

TABLE 2.4.2 Revision: E

MODEL 8000 REGULATOR PCB ASSEMBLY

Bill Of Materials

Item	Quant.	P/N	Ref.	Description/Manufacturer
1.	6	10001	C1,C5,C6, C7.C8,C9	CAP SM TANT 10uf 20v
2.	5	10002	C10,C11, C12,C13, C15	CAP SM TANT 4.7uF 50V
3.	1	12001	C16	CAP ALUM AXIAL 2200uF 50V
4.	3	11009	C2,C4,C14	CAP SM CER 1uf 50v
5.	2	11001	C3,C17	CAP SM CER 0.1uf 50v
6.	1	25107	D1	DIODE Zener 5.6V 5W
7.	1	25005	D2	DIODE LED Red T1
8.	4	25103	D3,D4,D5, D6	DIODE SM Schot Rec 3A 40V
9.	1	25101	D7	DIODE SM PROG ZENER
10.	1	87245	D8	Bridge Rectifier
11.	2	25303	F1,F2	Fuses, 2.5A Fast-Blow Sano SP5-2.5A
12.	1	25304	L1	Choke Torid 75uh 2A
13.	1	60002	PCB	PCB, Regulator
14.	1	25204	Q1	FET PMOS SM
15.	1	25201	Q2	TRANSISTOR PNP TO220 5A 60V
16.	1	25202	Q3	TRANSISTOR NPN SOT23 2N3904
17.	2	15015	R1,R8	RESISTOR SM 2.7k 1/4W 1% Mfilm
18.	2	15018	R10,R14	RESISTOR SM 8.2k 1/4W 1% MFilm
19.	1	15016	R11	RESISTOR SM 39k 1/4W 1% MFil
20.	1	17001	R12	POTENTIOMETER 2k 1-Turn
21.	1	15017	R13	RESISTOR SM 7.5k 1/4W 1% MFil
22.	2	15013	R2,R7	RESISTOR SM 1.0k 1/4W 1% MFil
23.	1	15019	R3	RESISTOR 100 K. 1/4W, 1% MFilm
24.	1	15001	R4	RESISTOR SM 10k 1/4W 1% MFilm
25.	1	15020	R5	RESISTOR SM 1650 1/4W 1% Mfilm
26.	1	16001	R6	RESISTOR 3.9 ohm 1/2W 2% Cfilm
27.	1	15014	R9	RESISTOR SM 20k 1/4W 1% MFil
28.	1	25308	U1	IC, SMPS Regulator TO220
29.	1	25309	U2	IC, SMPS 3-Lead Regulator
30.	1	35015	CBL1	REGULATOR HARNESS
31.	1	35016	CLB2	BATTERY HARNESS

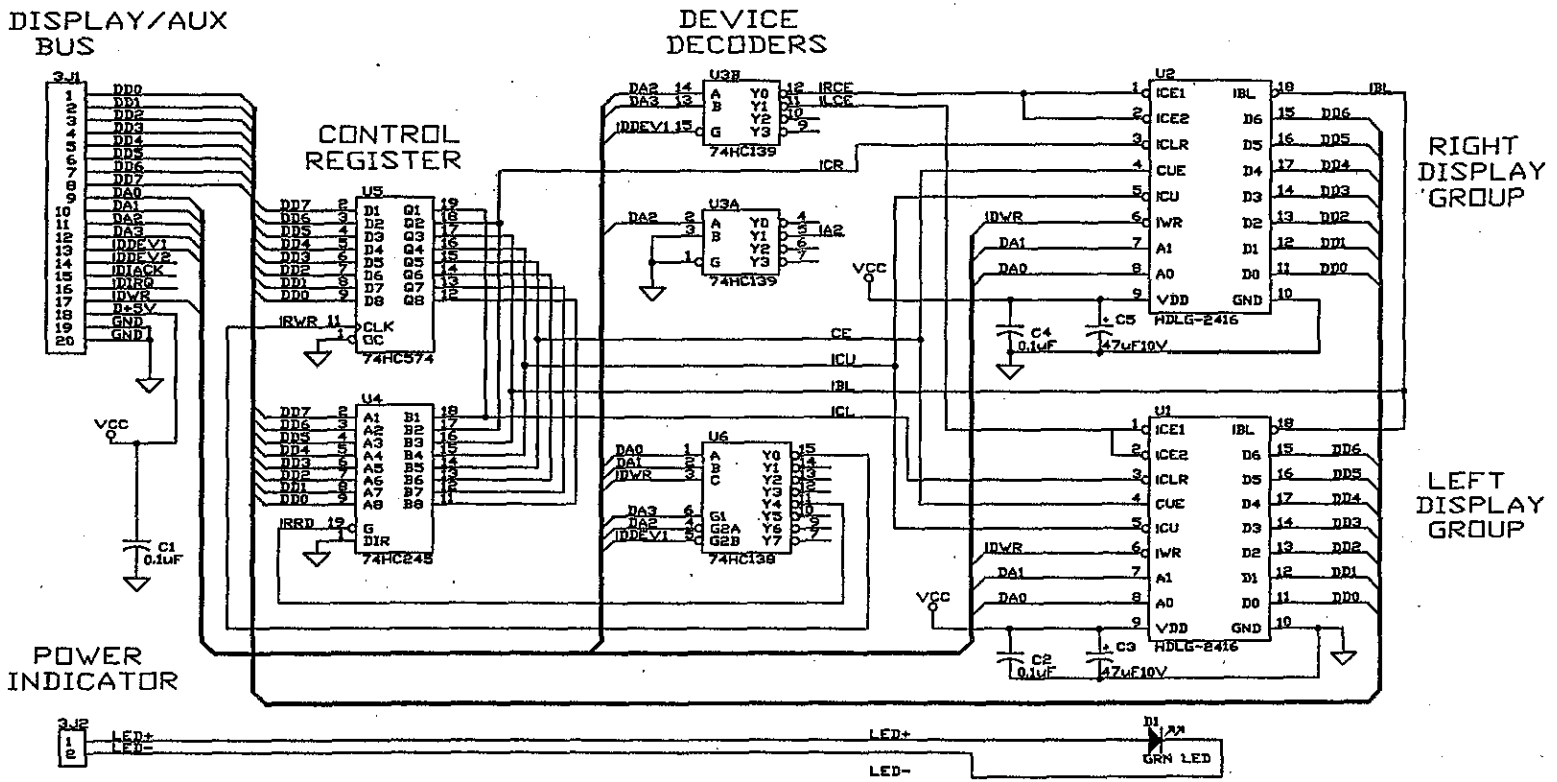


Figure 2.5.0

DISPLAY PCB SCHEMATIC

SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 60006s1.DWG

FILE E:\ORCAD386\HC16\DISPS1C.SCH

DRAWN: HUFNAGEL 1/28/94
DP 7/8/96
TU 7/9/96
CM 7/10/96
RB 7/9/96

December 29, 1995

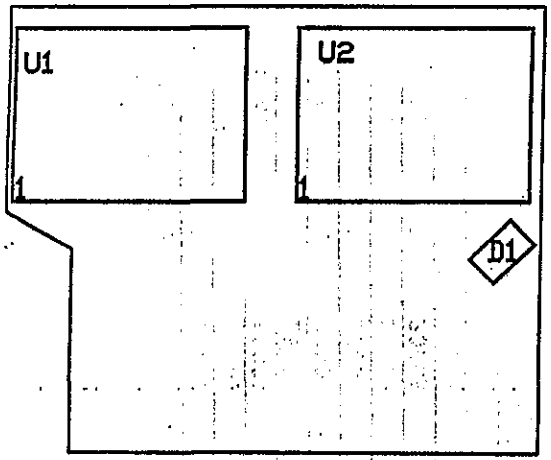
SIGMA International
711 PARK AVENUE
Medina, NY 14103-0756
TEL.(716)798-3901
FAX (716)798-3909

sigma International

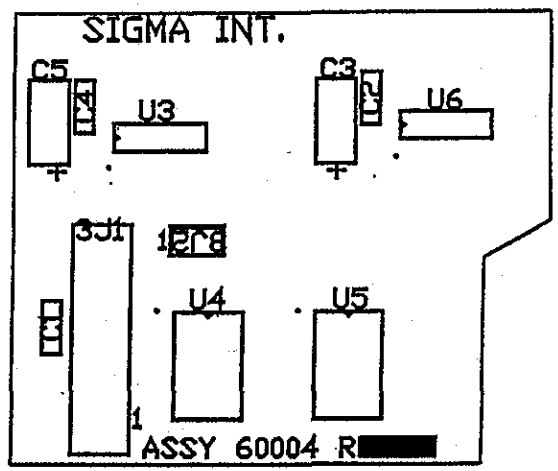
MODEL 8000 DISPLAY BOARD

SIZE B | CAGE CODE | DWG NO 60006 | REV C

SCALE | SHEET 1 OF 2



FRONT VIEW



BACK VIEW

Figure 2.5.1

DISPLAY PCB ASSEMBLY

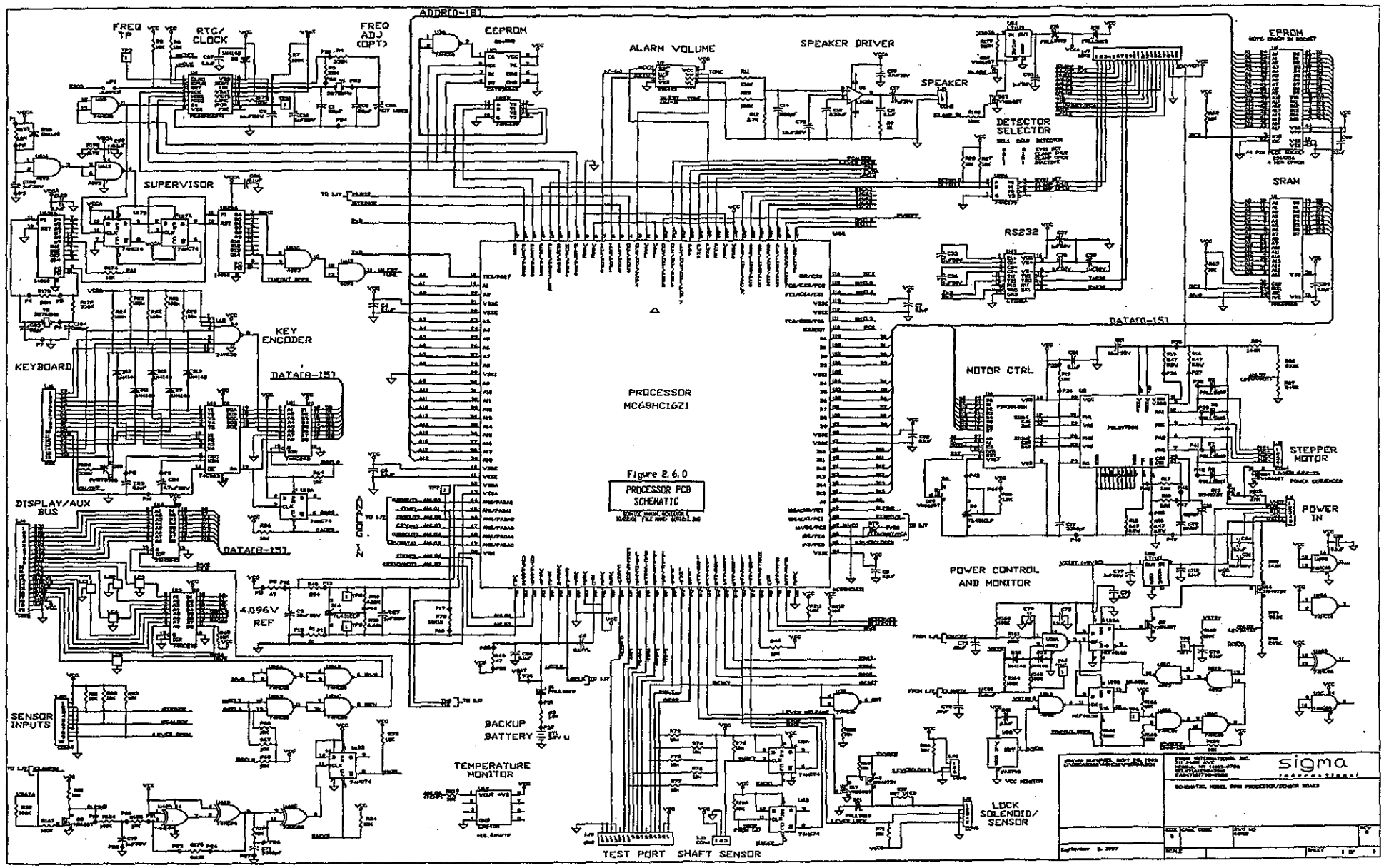
SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 60004.DWG

TABLE 2.5.2 Revision: E

DISPLAY PCB, MODEL 8000

Bill Of Materials

Item	Quant.	P/N	Ref.	Description/Manufacturer
1.	3	11001	C1,C2,C4	CAP,cer,0.1uf,50V,20%,X7R/Z5U SM
2.	2	10005	C3,C5	CAP,tant,47uf,10V,20%SM
3.	1	25001	D1	GRN LED, RECTANGULAR TH
4.	1	60005	PCB	PCB BLANK
5.	2	25002	U1,U2	DISPLAY, GREEN TH
6.	1	20002	U3	74HC139 SM
7.	1	20003	U4	74HC245 SM
8.	1	20004	U5	74HC574 SM
9.	1	20005	U6	74HC138 SM
10.	1	30007	3J1	HEADER,20-p,RA,2mm pc hdr TH
11.	1	30012	3J2	HEADER,2-P,H,2mm pc hdr TH
12.	REF	35021	CBL1	LED INDICATOR CABLE
13.	REF	35113	CBL2	DISPLAY PCB W/EXT


FREQ TP
RTC/ CLOCK
FREQ ADJ (OPT)
ADDR[0-18]
EEPROM
ALARM VOLUME
SPEAKER DRIVER
SPEAKER
DETECTOR SELECTOR
EPROM
SRAM
SUPERVISOR
RS232
DATA[0-15]
KEY ENCODER
KEYBOARD
DATA[8-15]
PROCESSOR MC68HC16Z1
MOTOR CTRL
STEPPER MOTOR
DISPLAY/AUX BUS
DATA[8-15]
POWER IN
POWER CONTROL AND MONITOR
4.096V REF
SENSOR INPUTS
BACKUP BATTERY
TEMPERATURE MONITOR
LOCK SOLENOID/ SENSOR
TEST PORT
SHAFT SENSOR
Figure 2.6.0
PROCESSOR PCB SCHEMATIC
sigma

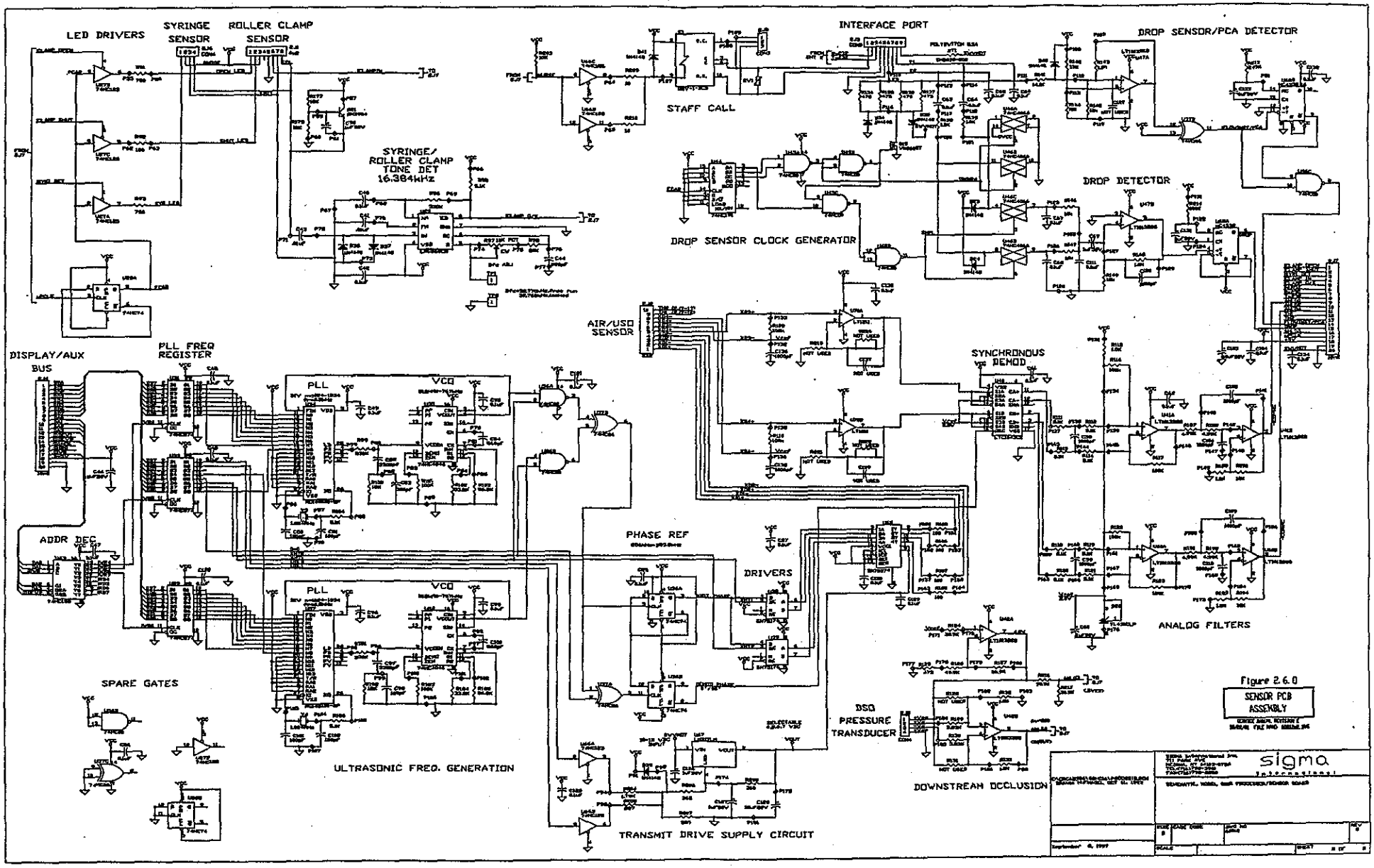


Figure 2.6.0
SENSOR PCB ASSEMBLY

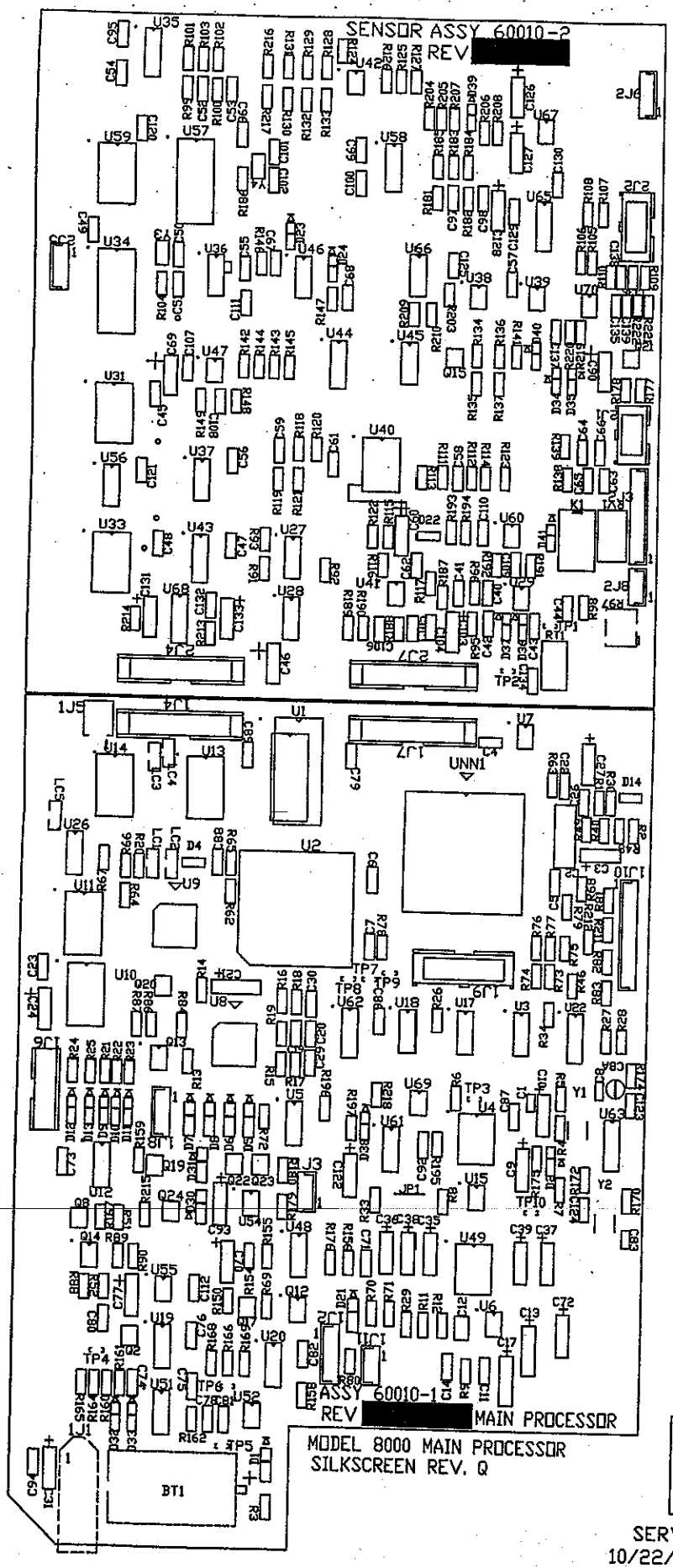


Figure 2.6.1

PROCESSOR SENSOR PCB ASSEMBLY

TABLE 2.6.2 Revision: E

MODEL 8000 PROCESSOR PCB ASSEMBLY

Bill Of Materials

Item	Quant.	P/N	Ref.	Description/Manufacturer
1.	1	55003	BT1	BATTERY,3.6V,0.75Ah,1/2AA,Li/TCl
2.	3	11002	C1,C8,C83	CAP,cer,22pf,100V,C0G,5% SM
3.	18	10003	C10,C27,C35, C36,C37,C38, C39,C60,C69, C70,C77,C90, C93,C122, C126,C127, C131,C133	CAP, tant, 1uf, 50V, 20% SM
4.	1	11010	C12	CAP,cer,.33uf,50V,20%,X7R/Z5U SM
5.	2	10005	C13,C17	CAP,tant,47uf,10V,20% SM
6.	10	11007	C14,C58,C59, C105,C106, C108,C109, C110,C136, C138	CAP,cer,1000pf,50V,10%,C0G SM
7.	4	11008	C19,C52,C71, C97	CAP,cer,3300pf,50V,10%,C0G SM
8.	1	12002	C2	CAP,myl,0.1uf,100V,10% TH
9.	1	10004	C21	CAP,tant,10uf,35V,20% SM
10.	1	10006	C24	CAP,tant,4.7uf,35v,10% TH
11.	3	11006	C29,C30,C44	CAP,cer,820pf,100v,10%,C0G SM
12.	7	10001	C3,C9, C31,C46, C72,C103, C128	CAP,tant,10uf,20V,20% SM
13.	53	11001	C4,C5,C6,C7, C11,C20,C22, C23,C26,C40, C42,C45,C47, C48,C49,C55, C56,C57,C61, C62,C63,C64, C65,C66,C67, C68,C74,C75, C76,C78,C81, C82,C86,C87, C88,C89,C92, C94,C95,C96, C99,C104, C111,C112, C120, C123, C129, C130, C132, C134, C135	CAP,cer,0.1uf,50V,20%,X7R/Z5U SM
14.	5	11005	C41,C43,C73, C79,C80	CAP,cer,.01uf,100v,10%,X7R TH
15.	7	11003	C50,C51,C53. C98,C101, C102,C124	CAP,cer,100pf,100V,5%,C0G SM
16.	2	11004	C54,C100	CAP,cer,560pf,100V,5%,C0G SM
17.	8	25104	D1,D2,D3,D4, D5,D6,D7,D8, D21,D30,D31	DIODE,ref schtky 1A,40V SM

TABLE 2.6.2 Revision: E

MODEL 8000 PROCESSOR PCB ASSEMBLY

Bill Of Materials

Item	Quant.	P/N	Ref.	Description/Manufacturer
50.	6	16011	R4,R96,R99, R159,R172, R181	RESISTOR, 330KΩ, 1/4W, 5%, CF SM
51.	1	15022	R40	RESISTOR, 4.12KΩ, 1/4W, 1% MF SM
52.	1	15023	R48	RESISTOR, 294Ω, 1/4W, 1% MF SM
53.	2	16009	R5,R170	RESISTOR, 22MΩ, 1/4W, 5%, CF SM
54.	50	16004	R6,R8,R26, R27,R28,R33, R34,R46,R51, R62,R63,R64, R65,R66,R67, R68,R69,R71, R72,R73,R74, R75,R76,R77, R78,R79,R80, R81,R82,R83, R144,R145, R146,R147, R149,R150, R155,R156, R158,R166, R174,R177, R178,R190, R194,R196, R203,R211, R212,R218	RESISTOR, 10KΩ, 1/4W, 5%, CF SM
55.	27	16005	R7,R21,R22, R23,R24,R25, R52,R101, R109,R110, R116,R117, R122,R123, R154,R160, R161,R162, R164,R165, R167,R168, R169,R175, R180,R183, R214	RESISTOR, 100KΩ, 1/4W, 5%, CF SM
56.	2	15027	R84,R141	RESISTOR, 237Ω, 1/4W, 1% MF SM
57.	4	15011	R86,R89, R176,R179	RESISTOR, 953KΩ, 1/4W, 1%, MF SM
58.	3	15004	R87,R90,R213	RESISTOR, 249KΩ, 1/4W, 1%, MF SM
59.	1	15031	R88	RESISTOR, 14K, 1/4W, 1% SM
60.	2	16020	R91,R93	RESISTOR, 750Ω, 1/4W, 5%, CF SM
61.	1	16022	R92	RESISTOR, 180Ω, 1/4W, 5% CF SM
62.	11	16018	R95,R104, R111,R112, R113,R114, R118,R119, R120,R121, R186	RESISTOR, 5.1KΩ, 1/4W, 5%, CF SM
63.	1	17002	R97	POTENTIOMETER, 10KΩ SM

TABLE 2.6.2 Revision: E

MODEL 8000 PROCESSOR PCB ASSEMBLY

Bill Of Materials

Item	Quant.	P/N	Ref.	Description/Manufacturer
64.	1	16008	R98	RESISTOR, 20KΩ, 1/4W, 5%, CF SM
65.	1	25310	RT1	POLYSWITCH, .03 A TH
66.	1	25316	RV1	METAL OXIDE VARISTOR SM
67.	1	20030	RU1	IC, SRAM, 32Kx8, SOP SM
68.	1	20012	U10	IC, KYBDCTRL, 74C923 SM
69.	3	20003	U11,U13,U14	IC, OCTBUF, 74HC245 SM
70.	1	20013	U12	IC, 8INNAND, 74HC30 SM
71.	1	20014	U15	IC, SER EEPROM, 2Kx8 SM
72.	1	20016	U19	IC, DDFF, CD4013B SM
73.	1	20002	U22	IC, D2TO8ENC. 74C139 SM
74.	2	20019	U27,U66	IC, QTRISTATE, 74HC125 SM
75.	1	20023	U29	IC, TONEDETECT, LMC568 SM
76.	5	20032	U3,U20,U26, U45,U56	IC, QNAND, 74HC00 SM
77.	3	20004	U31,U33,U59	IC, 8BLATCH, 74HC574 SM
78.	2	20024	U34,U57	IC, PLL MC145151 SM
79.	1	20021	U35,U58	IC, VCO/PLL, 74HC4046 SM
80.	2	20017	U37,U48	IC, QXOR, 74HC86 SM
81.	2	20028	U38,U39	IC, DIFFBUS SN75176 SM
82.	1	20006	U4	IC, RTC, 68HC1621 SM
83.	1	20026	U40	IC, SWCAPAMP, LTC1043 SM
84.	4	20025	U41,U42,U47, U60,	IC, DOPAMP, LT1013 SM
85.	1	20005	U43	IC, 74HC138 SM
86.	1	20020	U44	IC, 4BITUPDN 74HC191 SM
87.	1	20022	U46	IC, QSWITCH, 74HC4066 SM
88.	1	20027	U49	IC, RS232INT, MAX232 SM
89.	5	20007	U5,U17,U18, U28,U36	IC, DDFF, 74HC74 SM
90.	1	20034	U51	IC, MC14093 SM
91.	1	20035	U52	IC, MAX709 SM
92.	2	20033	U54,U55	IC, LT1121CS8-5 SM LINEAR TECH LT1121CS8-5
93.	1	20008	U6	IC, PWRAMP, LM386M-1 SM
94.	2	20036	U62,U63	IC 4060 SM
95.	1	20038	U65	IC SN75374 SM
96.	1	20039	U67	IC LM317LM SM
97.	1	20040	U68	IC 74HC4538 SM
98.	1	20041	U69	IC LM34DM SM
99.	1	20042	U70	IC LT1211 SM
100.	1	20010	U8	IC, MOTDRV, PBL3772QN SM
101.	1	20009	U7	IC, EEPOT, 10K, X9C103 34SM
102.	1	20011	U9	IC, MOTCTRL, PBM3960QN SM
103.	1	20029	UNN1	IC, uCONTR,16MHz,MC68HC16Z1 SM
104.	2	25312	Y1,Y2	XTAL, 32.768kHz SM
105.	2	25313	Y3,Y4	CERAMIC RESONATOR, 1.024MHz TH
106.	1	30013	1J1	PLUG, 5-PIN TH
107.	1	30003	1J10	HEADER, 10-P,2mm pc pin hdr TH
108.	5	30036	1J1P	PIN, PROCESS PCB TH
109.	1	30011	1J2	HEADER,5-P,V,2mm pc pin hdr TH
110.	1	30017	1J5	HEADER,2-P,V,2mm pc pin RT angle TH
111.	1	30008	1J6	HEADER,16-P,V,2mm pc pin hdr TH
112.	1	30010	2J1	HEADER,8-P,V,2mm pc pin hdr TH

TABLE 2.6.2 Revision: E

MODEL 8000 PROCESSOR PCB ASSEMBLY

Bill Of Materials

Item	Quant.	P/N	Ref.	Description/Manufacturer
113.	1	30009	2J2	HEADER,10-P,V,2mm pc pin hdr TH
114.	1	30012	2J3	HEADER,9-PIN, Fem, 2mm TH
115.	3	30020	1J3,1J11,2J8	HEADER,3-P TH
116.	3	30006	1J8,2J5,2J6	HEADER,4-P,V,2mm pc pin hdr TH
117.	4	30007	1J4,1J7,2J4, 2J7	HEADER,20-P,RA,2mm pc pin hd TH

DATE	DWG	REVISION RECORD	ECN	
2/96	A	RELEASED TO PRODUCTION		DDS
7/96	B	ITEM 3 QTY WAS 2, DIM WAS 15		DDS
10/96	C	DELETED THE EAR AND APPLIED MOTION	06096	DDS
4/97	D	REMOVE ITEMS 3 & 4, NOTE 3 AND 15" DIMENSION	04897	DDS

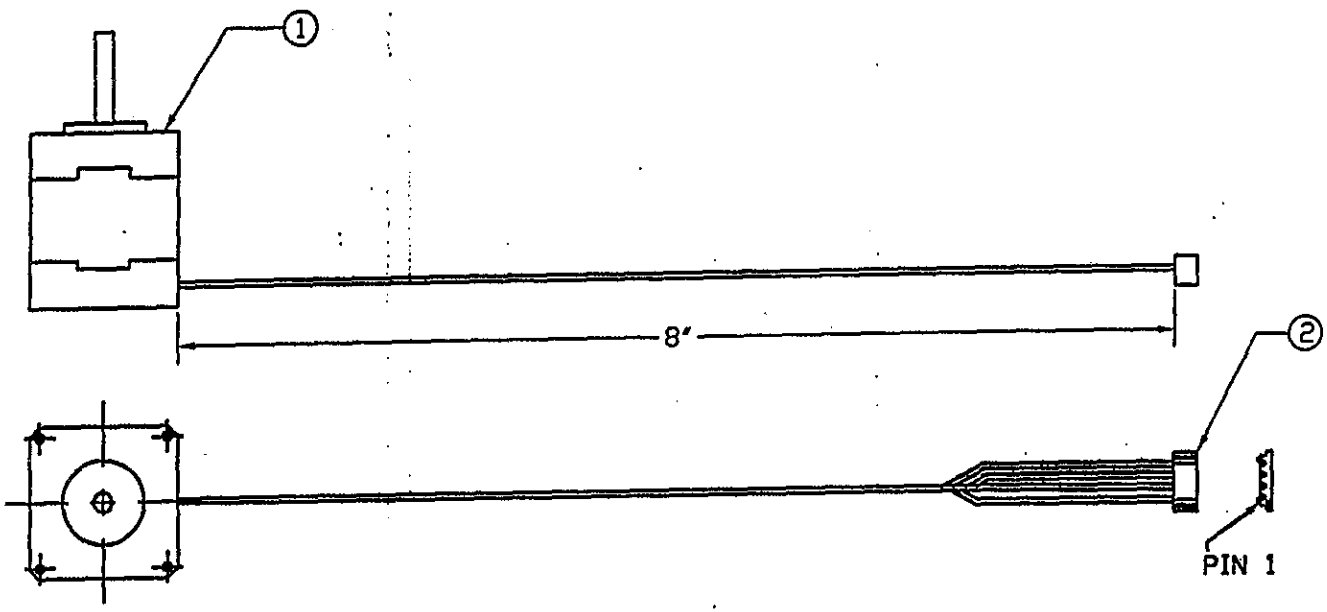


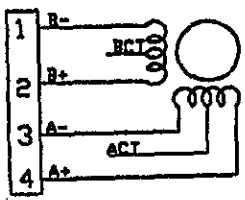
Figure 2.7.1
MOTOR ASSEMBLY CABLE
SERVICE MANUAL REVISION C
10/28/97 FILE NAME: 35032.DWG

NOTES:
1. ASSEMBLE PER MWI # 35004
2. VERIFY THAT ALL WIRES ARE FULLY SEATED INTO THE CONNECTOR.

△D

△D 4			
△D 3			
2	30022	1	Connector 4 PIN
1	55013	1	Stepper Motor
ITEM	P/N	QTY	DESCRIPTION

SCHEMATIC



WIRE COLORS

	MANUF	A+	ACT	A-	B+	BCT	B-
	MYCOM	RED	BRN	WHT	YEL	BRN	BLU

FILE: 35032D

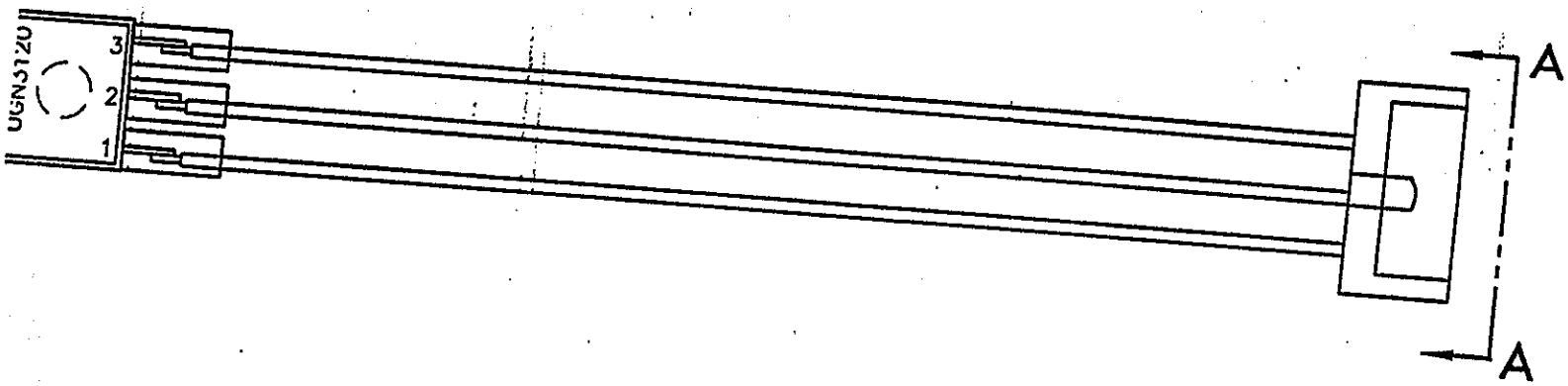
DRAWN BY: BTH	TOLERANCES	SIGMA INTERNATIONAL, INC. 711 PARK AVENUE MEDINA, NEW YORK 14103	
DESIGNED BY:	DECIMAL ± .25	TITLE MOTOR ASSEMBLY CABLE	
PROJECT ENG.:	FRACTIONAL ± N/A	PRODUCT USED ON 8000	SCALE NTS
MANAGEMENT:	ANGULAR N/A	DATE 4-21-97	REVISION D
PRODUCTION MGR.: T. UNDERWOOD 4-25-97			NEXT ASSEMBLY 35004
ENGINEERING DIR.: C. MARTINA 4-28-97			DRAWING NUMBER 35032
QA/PCS DIR.: R. BRANDT 4-28-97			

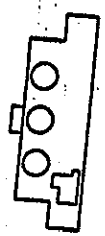
TABLE 2.7.2 Revision: E

MODEL 8000 MOTOR ASSEMBLY

Bill Of Materials

Item	Quant.	P/N	Description/Manufacturer
1.	1	55013	MOTOR,stepping,4V,1.2A,3.3ohm,1.8deg
2.	1	30022	CONNECTOR,2mm





VIEW A—A

Figure 2.8.1

SHAFT SENSOR ASSEMBLY

SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 35033.DWG

SCHEMATIC

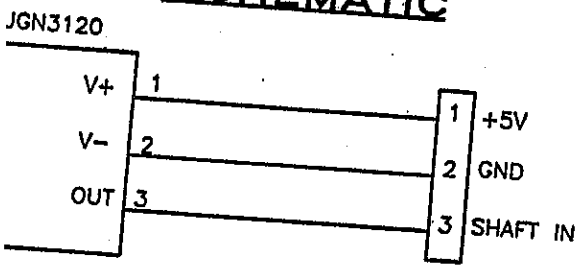
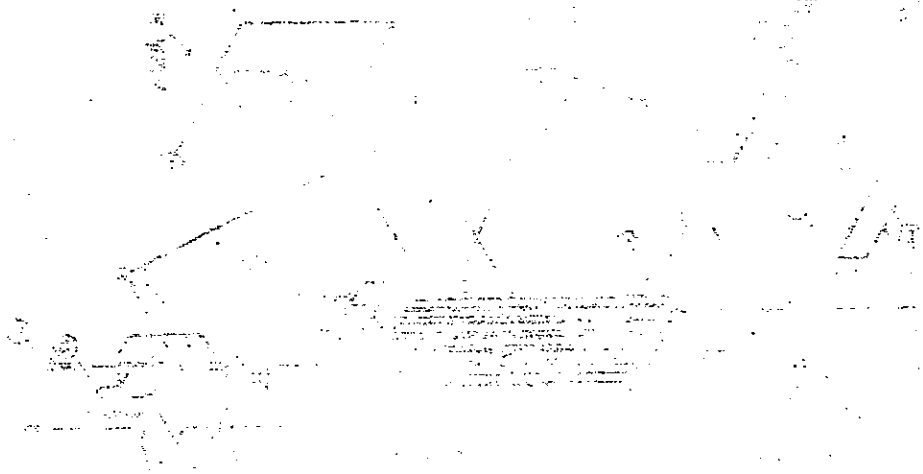


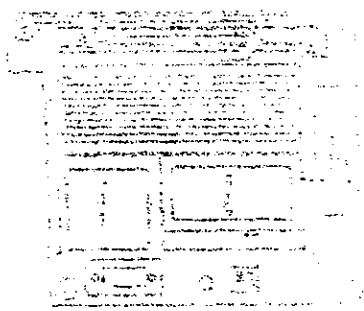
TABLE 2.8.2 Revision: E

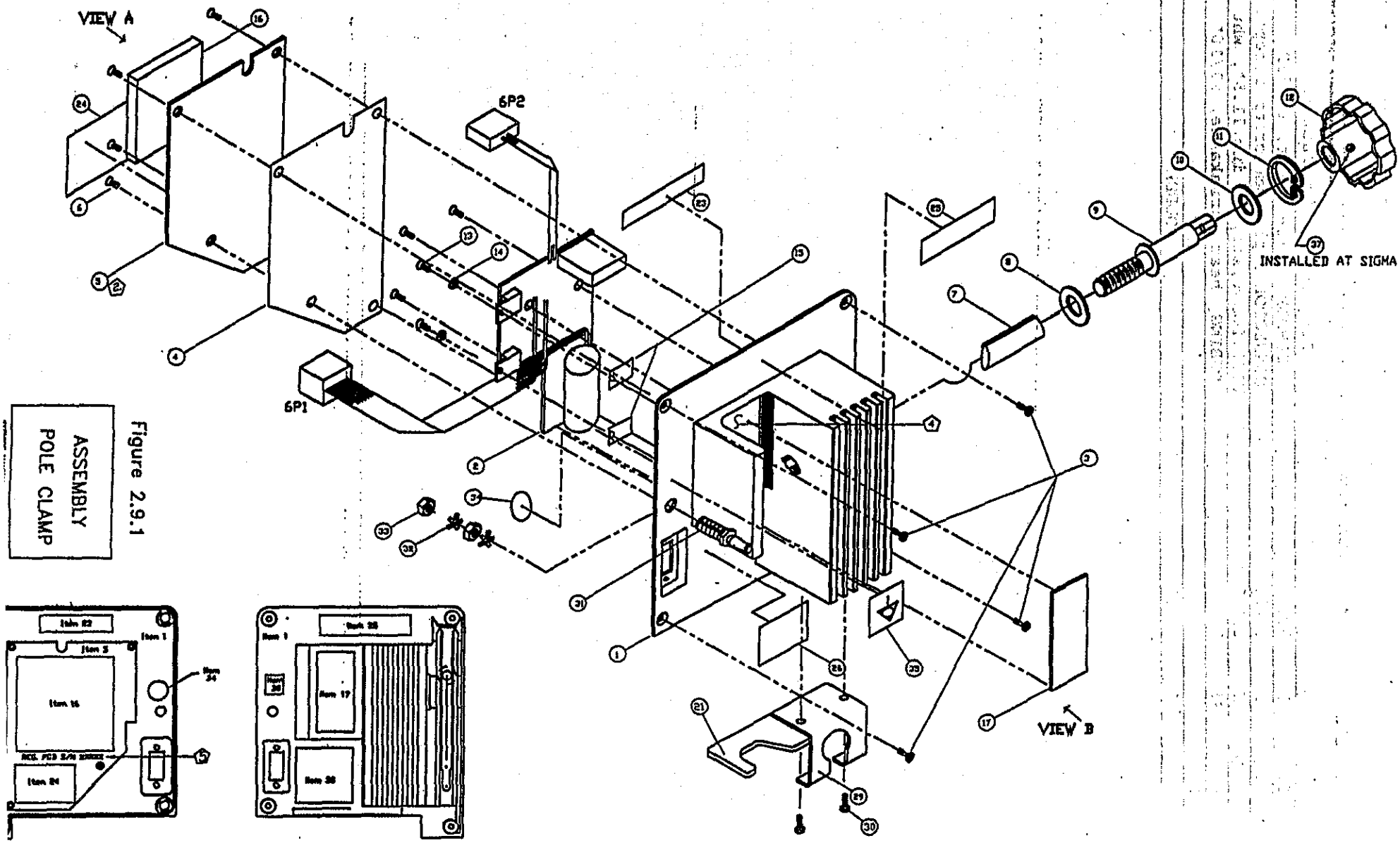
MODEL 8000 SHAFT SENSOR ASSEMBLY

Bill Of Materials

Item	Quant.	P/N	Ref.	Description/Manufacturer
1.	1	70041		SENSOR, Hall-effect, UGN3120
2.	1	30035		CONNECTOR,3-pin,2mm,crimp recept
3.	AR	35107		WIRE,26awg,str,pvc ins,11.5", wht
4.	AR	35203		TUBING, heat shrinkable, i1/16"
5.				
6.	AR	90007		SOLDER







ASSEMBLY
POLE CLAMP

Figure 2.9.1

VIEW A
LABEL PLACEMENT

VIEW B
LABEL PLACEMENT

TABLE 2.9.2 Revision: E

MODEL 8000 Back Panel/Pole Clamp Assembly

Bill Of Materials

Item	Quant.	P/N	Ref.	Description/Manufacturer
1.	1	50026		BACK PANEL/POLE CLAMP
2.	1	60001		ASSEMBLY-REGULATOR PCB
3.	4	95029		SCREW - CAPTIVE
4.	1	40025		GASKET - COVER PLATE
5.	1	50005		COVER PLATE
6.	4	95004		SCREW 2-56 X 3/16
7.	1	45040		PLUNGER
8.	1	95108		WASHER - RED FIBER
9.	1	50007		SHAFT - DOUBLE LEAD THD
10.	1	95102		WASHER
11.	1	95109		SNAP RING
12.	1	55022		KNOB - POLE CLAMP
13.	5	95018		SCREW 4-40 X 1/4 BH
14.	2	95116		SHOULDER WASHER - NYLON
15.	2	86727		SIL-PAD
16.	1	40032		SPACER BATTERY COMP
17.	1	40023-2		POLE CLAMP PAD
18.	AR	90012		ALCOHOL
19.				
20.				
21.	1	50027		ANTI-TIP ADAPTER
22.	AR	90019		ADHESIVE - LOCTITE 406
23.	1	40037		LABEL - BATTERY SPEC.
24.	1	40038		LABEL - INTERNAL FUSE SPEC.
25.	1	40016		LABEL - CSA
26.	1	40009		LABEL - RS-232
27.	AR	T106		SANDPAPER - 220 GRIT
28.	AR	90023		HIGH VACUUM GREASE
29.	1	50025		CORD RETAINER
30.	2	85037		SCREW - 8-32 x 1/8"
31.	1	86690		EXTERNAL GROUND STUD
32.	2	85205		WASHER STAR 6mm
33.	2	85134		NUT 6mm
34.	1	86340		LABEL - GROUND
35.	1	40012		LABEL - EQIUPOTENTIALITY
36.				
37.	1	95036		SET SCREW - 8-32 x 3/8"

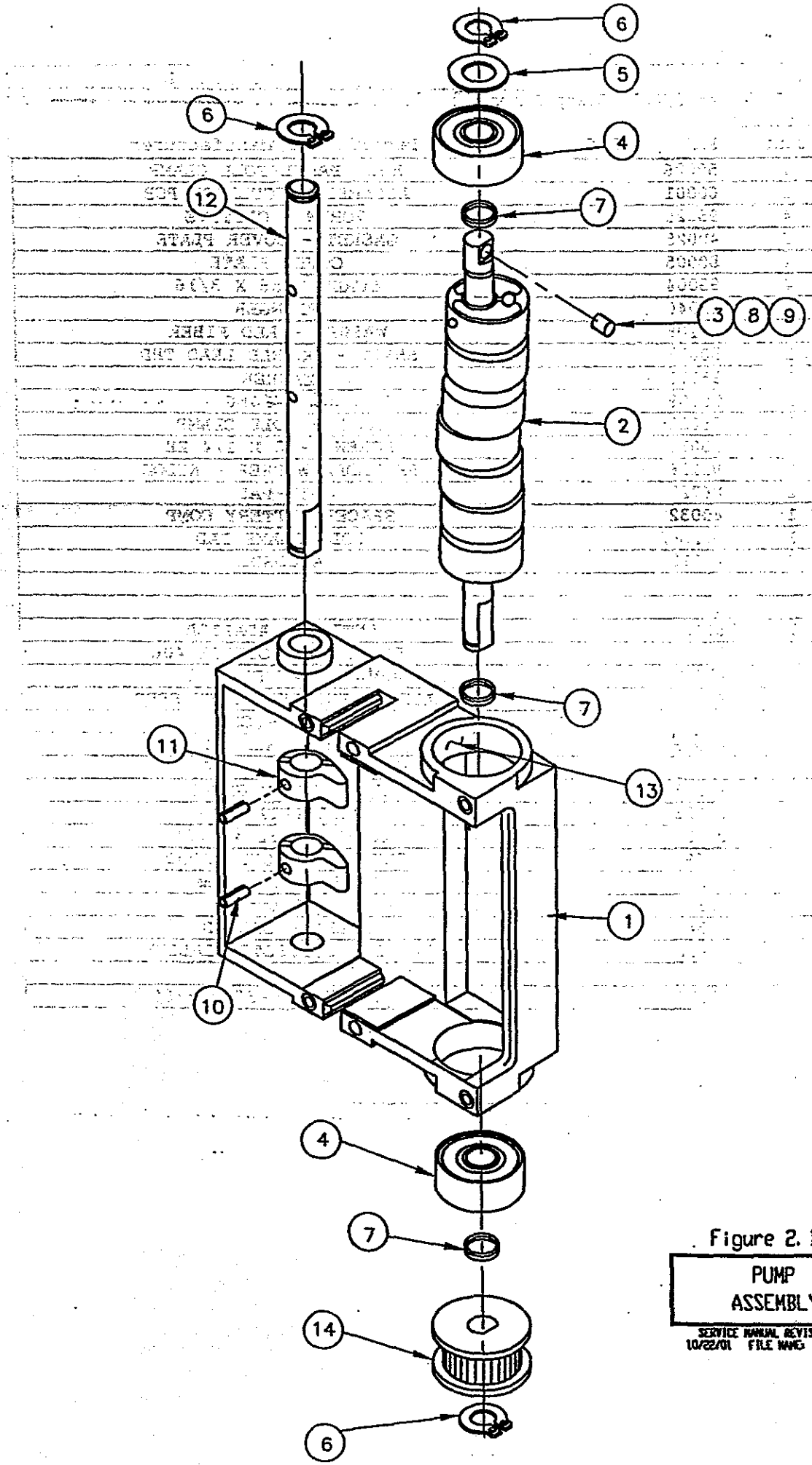


Figure 2.10.1

PUMP ASSEMBLY

SERVICE MANUAL REVISION E
10/22/01 FILE NAME 35035.DWG

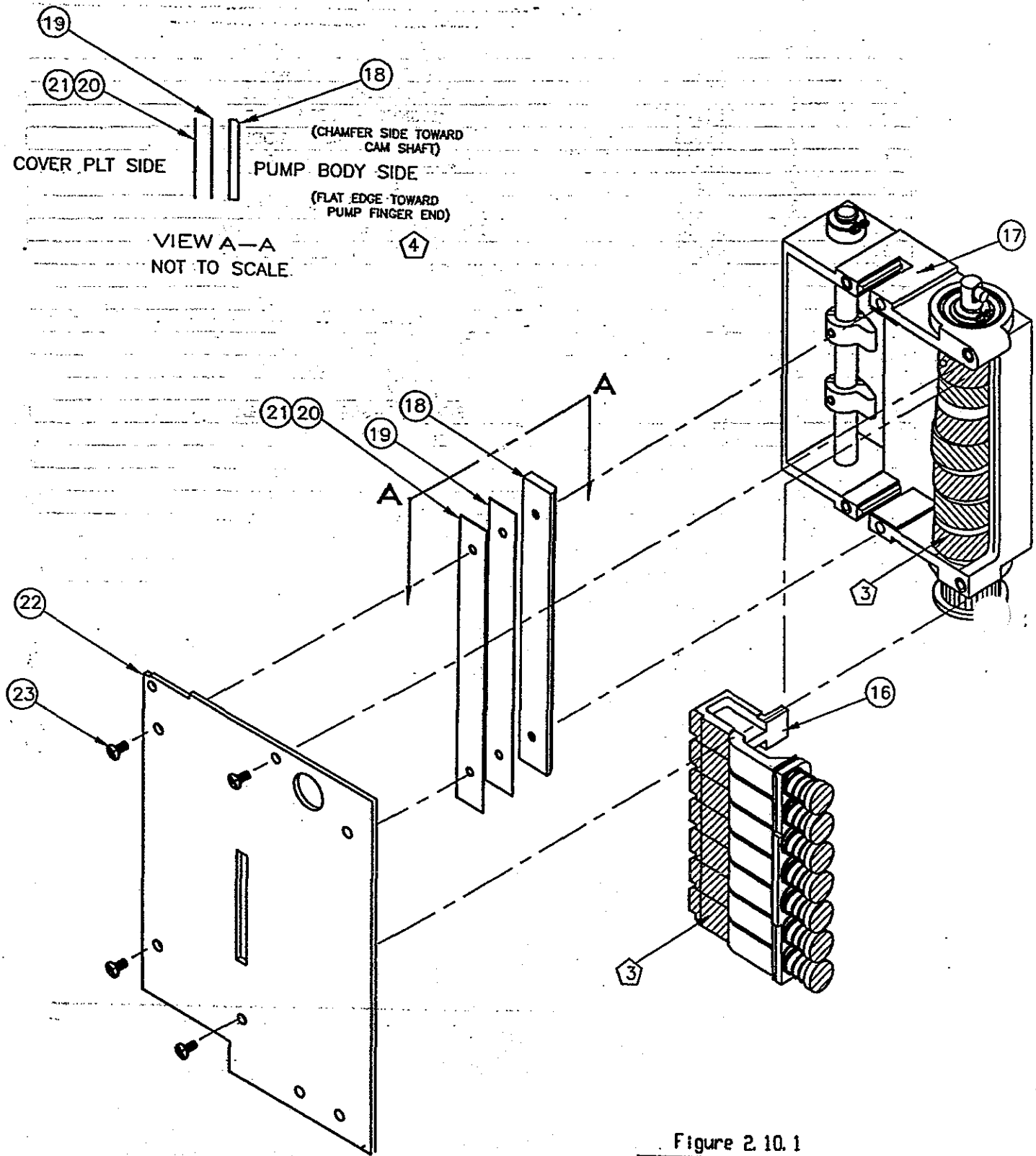


Figure 2.10.1

PUMP ASSEMBLY

TABLE 2.10.2 Revision: E

MODEL 8000 35005 Pump Assembly

Bill Of Materials

Item	Quant.	P/N	Description/Manufacturer
1.	1	45030	PUMP BODY - RAW
2.	1	35006	CAM SHAFT ASSEMBLY
3.	1	55024-2	MAGNET - .375 LNG
4.	2	55021	BEARING - SHIELDED
5.	1	95103	WASHER .265 x .500
6.	3	95104	SNAP RING
7.	3	70112	SPACER - BRASS CAM SHAFT
8.	AR	90005	LOCTITE - #580 BLACK MAX
9.	AR	90025	LOCTITE - #712 PRIMER
10.	2	95026	ROLL PIN .093 DIA x .500 SS
11.	2	50030	ELLIPSE CAM - SS
12.	1	50001	SHAFT - LEVER
13.	AR	85249	ADHESIVE - LOCTITE #406
14.	1	45042	PULLEY, PUMP
15.	AR	80154	HIGH VACUUM GREASE
16.	1	35008	PUMP FINGER ASSEMBLY
17.	1	35005-1	PUMP SUB ASSEMBLY
18.	1	50018	GUIDE BAR
19.	1(OPT)	40029	MYLAR STICKER .010" THK.
20.	1(OPT)	40029-1	MYLAR STICKER .005" THK.
21.	1(OPT)	40029-2	MYLAR STICKER .0075" THK.
22.	1	50015	FACEPLATE
23.	4	95002	SCREW 4-40 X 3/16" FH.

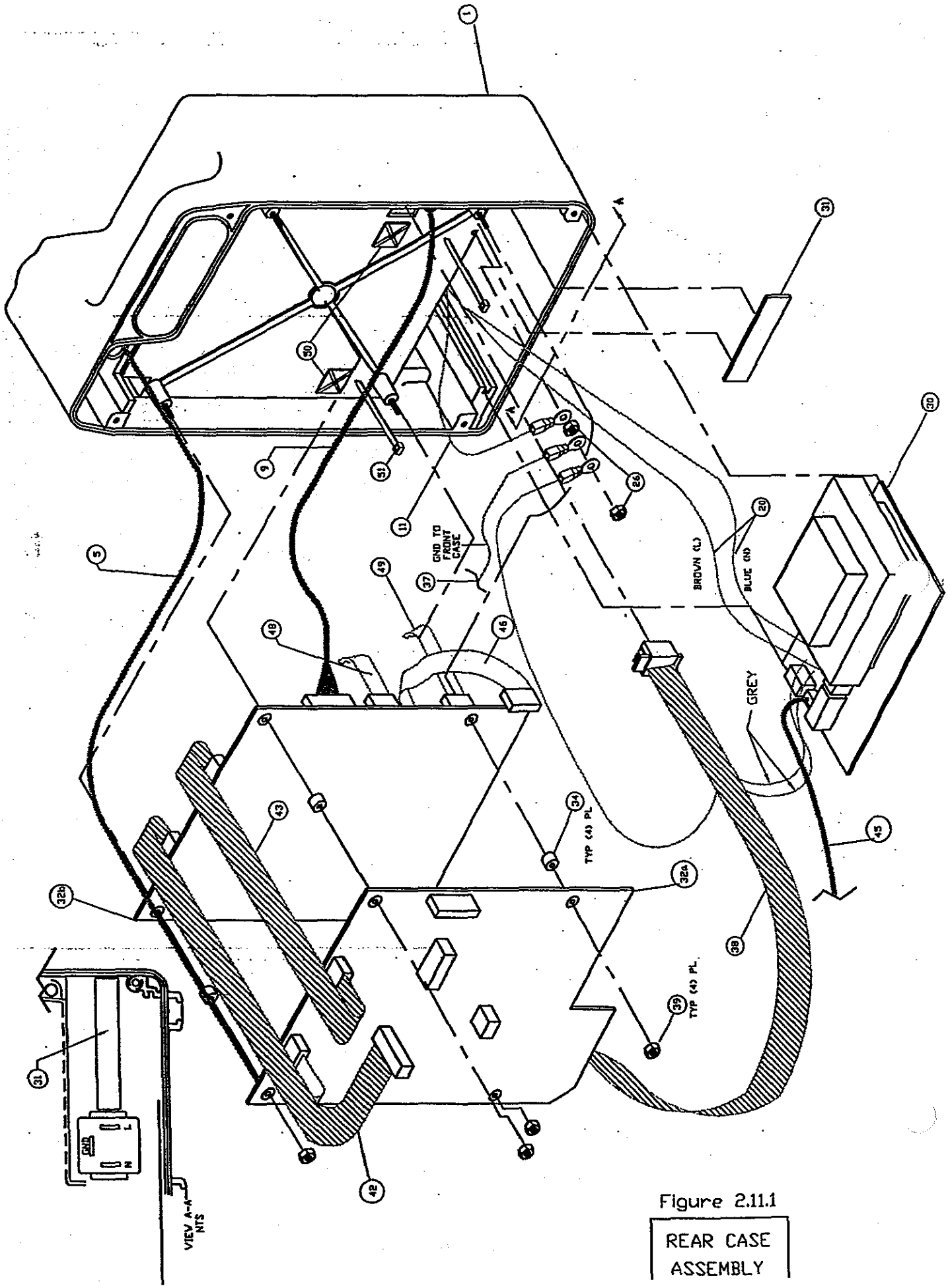


Figure 2.11.1

REAR CASE ASSEMBLY

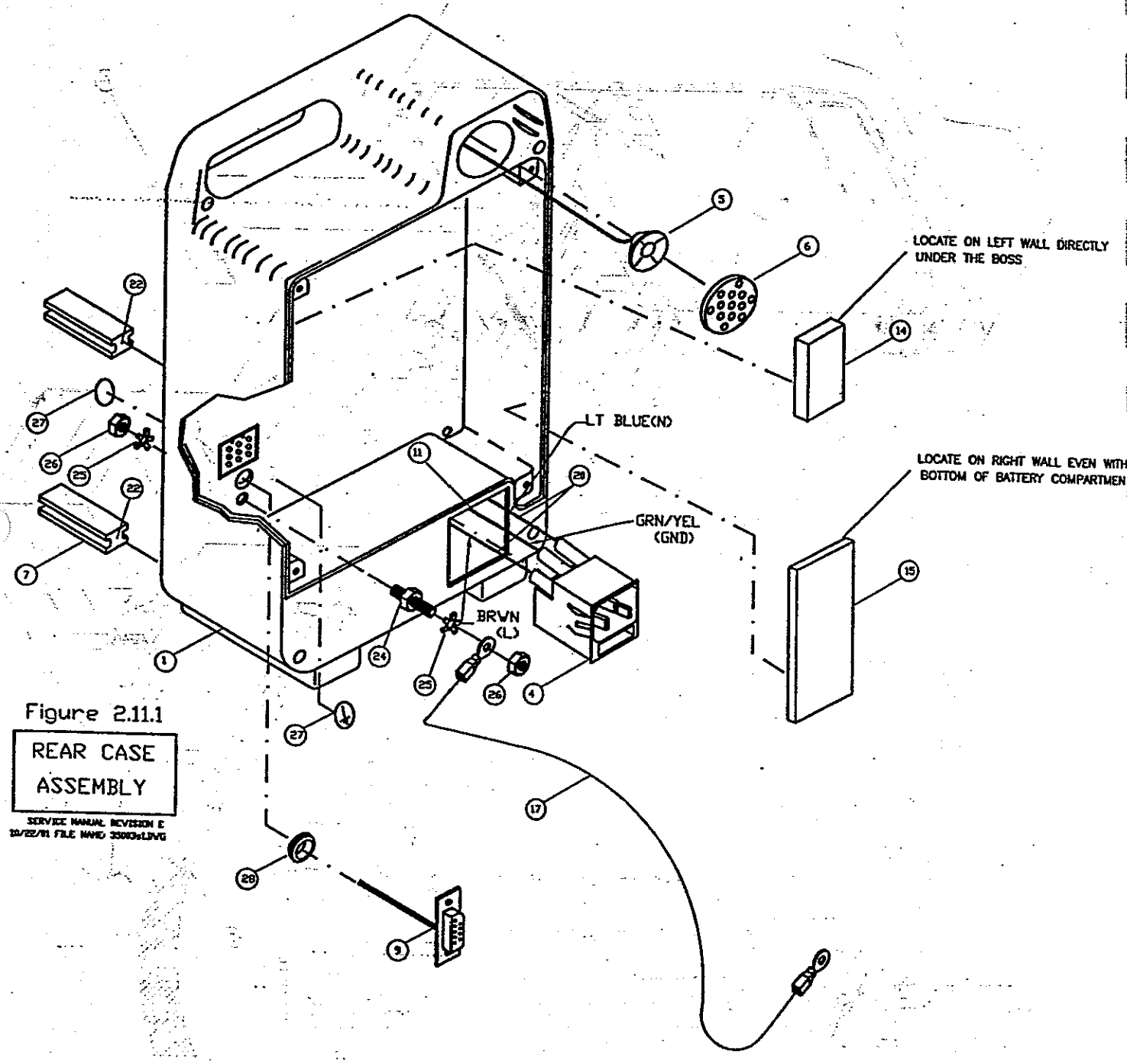

LOCATE ON LEFT WALL DIRECTLY UNDER THE BOSS
LT BLUE(N)
LOCATE ON RIGHT WALL EVEN WITH BOTTOM OF BATTERY COMPARTMEN
GRN/YEL (GND)
BRWN (L)

Figure 2.11.1

REAR CASE ASSEMBLY

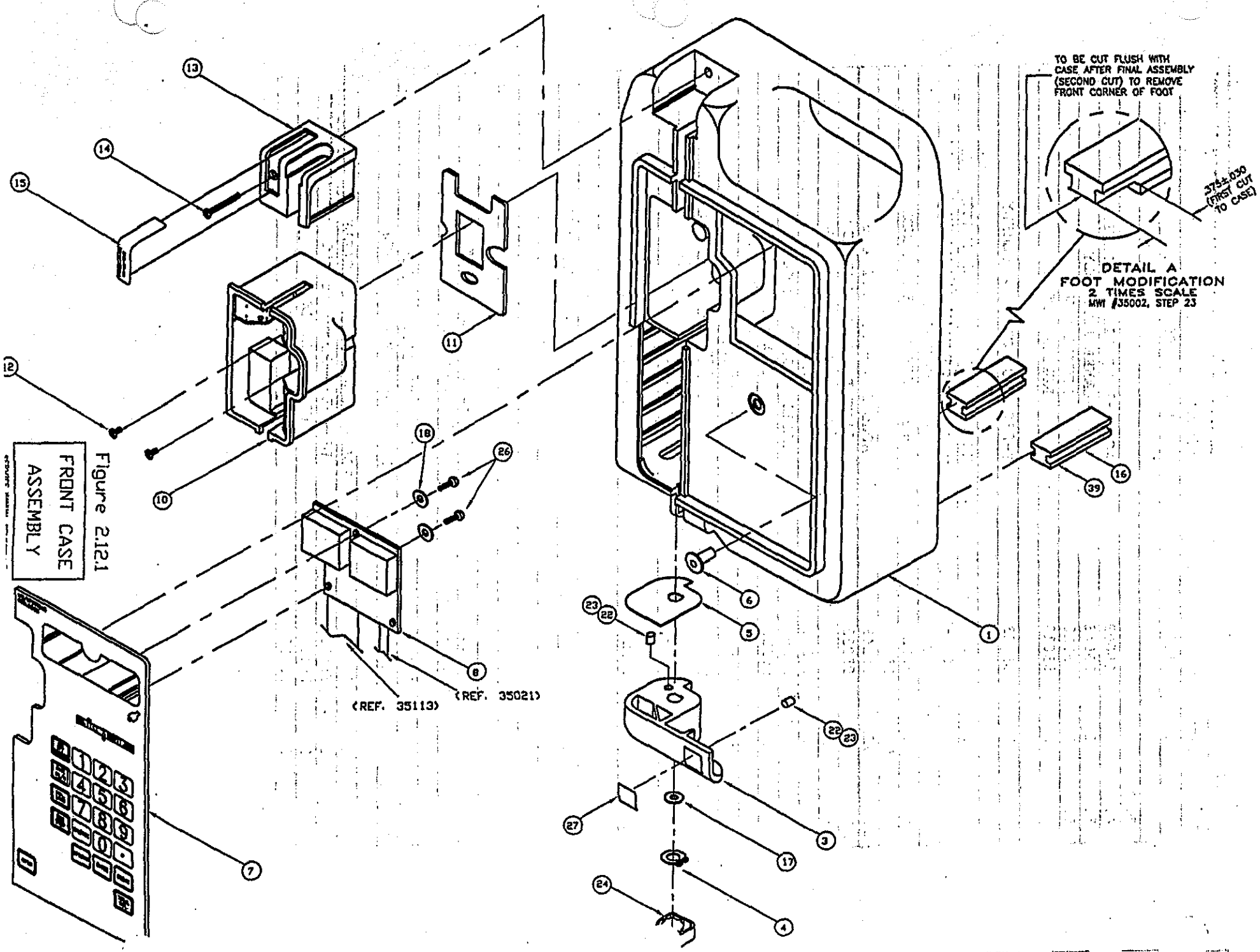
SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 33003eLDWG

TABLE 2.11.2 Revision: E

MODEL 8000 Rear Case Assembly

Bill Of Materials

Item	Quant.	P/N	Description/Manufacturer
1.	1	45020	REAR CASE MOLDED
2.			
3.			
4.	1	55009	AC IN-LINE FILTER MODULE
5.	1	35046	SPEAKER ASSEMBLY
6.	1	45022	SPEAKER CAP
7.	2	55018	RUBBER FEET
8.			
9.	1	35023	RS-232 JACK CABLE ASSEMBLY
10.			
11.	1	35044	BONDING WIRE - IN-LINE FILTER
14.	1	40032-1	FOAM PAD
15.	1	40032-3	FAOM PAD
17.	1	35028	BONDING WIRE - REAR PANEL
20.	REF	35017	LINE HARNESS
22.	AR	85249	ADHESIVE - LOCTITE 406
24.	1	95035	ADAPTER, MALE, GROUND
25.	2	85017	WASHER - EXTERNAL STAR
26.	4	85254	NUT - 8-32
27.	1	86340	LABEL - GROUND SYMBOL
28.	1	95130	GROMMET
29.			
30.	1	60007	TRANSFORMER PCBA
31.	1	40030	GASKET (TETRA SEAL 2.5")
32A.	1	60010-1a	PROCESSOR PCBA
32B.	1	60010-1b	SENSOR PCBA
33.			
34.	4	95124	SPACER - PCB
35.			
36.			
37.	1	35026	BONDING WIRE KEYPD/MTR MNT
38.	REF	35022	POWER SUPPLY CABLE
39.	4	95153	NUT - ESNA
40.			
41.			
42.	1	35113	DISPLAY CABLE W/EXT
43.	1	35116	J7 PROCESSOR CABLE
44.			
45.	1	35021	LED INDICATOR CABLE
46.	1	35038	DOWNSTREAM SENSOR CABLE
47.			
48.	1	35101	ROLLER CLAMP HOLDER CABLE
49.	1	35103	UPSTREAM SENSOR CABLE
50.	2	86484	WIRE HOLD DOWN
51.	2	85215	WIRE TIE


TO BE CUT FLUSH WITH CASE AFTER FINAL ASSEMBLY (SECOND CUT) TO REMOVE FRONT CORNER OF FOOT
.375±.030 (FIRST CUT TO CASE)
DETAIL A
FOOT MODIFICATION
2 TIMES SCALE
MWI #35002, STEP 23
(REF. 35113)
(REF. 35021)

FRONT CASE ASSEMBLY

Figure 2.12.1

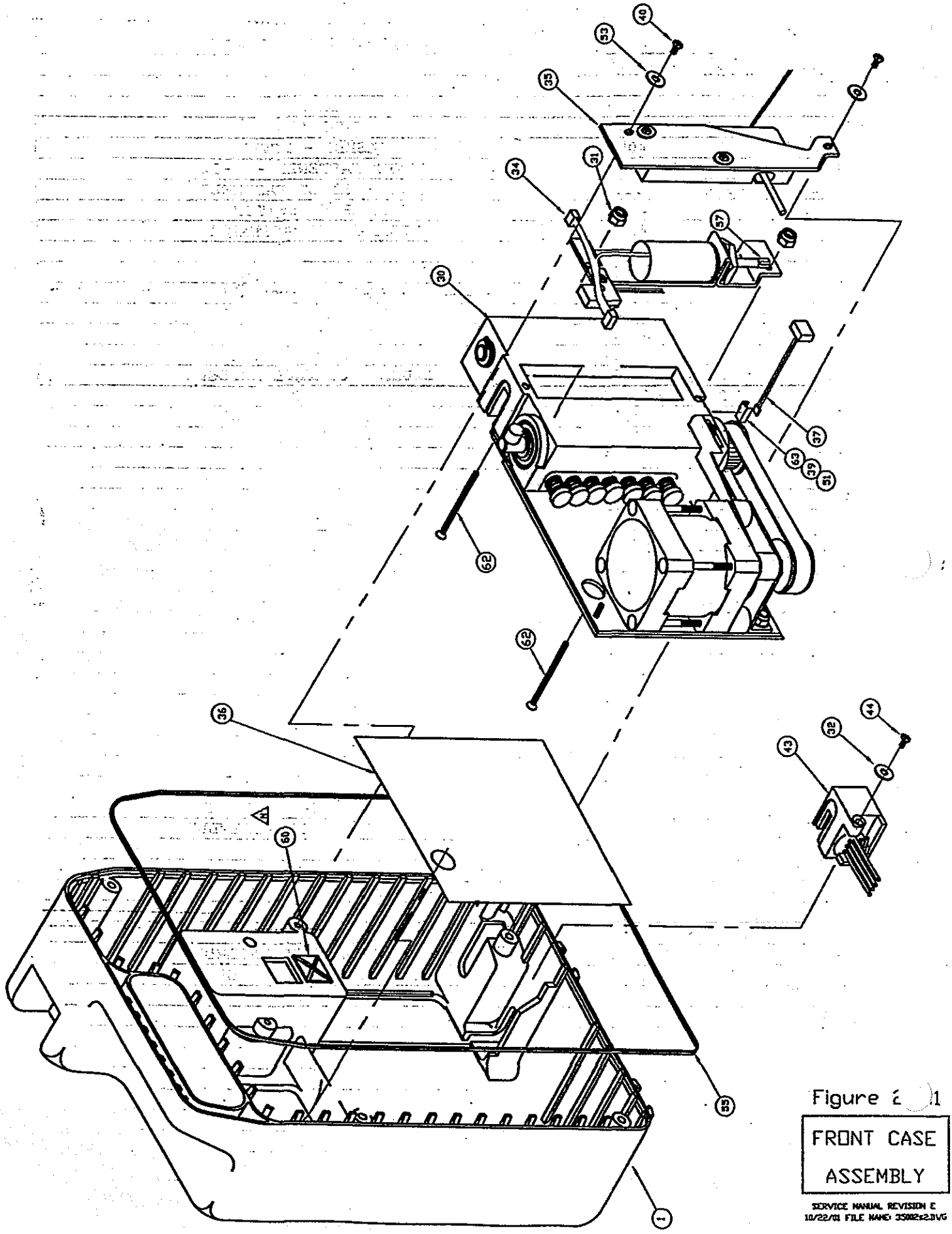


Figure 2-1

FRONT CASE ASSEMBLY

TABLE 2.12.2 Revision: E
MODEL 8000 35002 Front Case Assy.
Bill Of Materials

Item	Quant.	P/N	Description/Manufacturer
1.	1	45001	FRONT CASE
2.			
3.	1	45004	LEVER
4.	1	95104	SNAP RING
5.	1	40027	GASKET - LEVER
6.	1	95013	RIVET FASTENER - 6-32
6a.	REF.	T104	TOOL - RIVET FASTENER
7.	1	40001	MEMBRANE SWITCH
8.	1	60004	DISPLAY PCB ASSEMBLY
9.			
10.	1	35011	ASSEMBLY R. C. HOLDER
11.	1	40014	GASKET R.C. HOLDER
12.	2	95001	4-40 X 5/16 LNG (WHT)
13.	1	45005	SYRINGE HOLDER
14.	1	95014	4-40 x 1 3/8 LNG
15.	1	40017	LABEL - SYRINGE HOLDER
16.	2	55018	RUBBER FEET
17.	1	95103	WASHER .265 x .500
18.	2	95119	WASHER NYLON
19.			
20.			
21.			
22.	2	55024	MAGNET - LEVER
23.	AR	85234	ADHESIVE - LOCTITE 416
24.	1	45048	LEVER CAP
25.			
26.	3	85240	4-40 x ¼" PHMS
27.	1	40056	LABEL - LEVER ID
28.			
29.			
30.	1	35018	PUMP/MOTOR ASSEMBLY
31.	2	95153	ESNA NUT
32.	1	95101	WASHER #4
33.			
34.	1	35047	SOLENOID ASSEMBLY
35.	1	35009	BOLT HOUSE ASSEMBLY
36.	1	40031	GASKET -MOTOR/PUMP ASSEMBLY
37.	1	35045	LEVER OPEN CABLE ASSEMBLY
38.			
39.	AR	85249	ADHESIVE - LOCTITE 406
40.	2	95018	SCREW 4-40 x 1/4"
41.			
42.			
43.	1	35012	DOWNSTREAM SENSOR ASSEMBLY
44.	1	95011	SCREW 4-20 x 7/16 BH
45.			
46.			
47.			
48.			
49.			
50.			
51.	AR	85077	ACCELERATOR - LOCTITE 712
52.			

TABLE 2.12.2 Revision: E
MODEL 8000 35002 Front Case Assy.
Bill Of Materials

Item	Quant.	P/N	Description/Manufacturer
53.	2	85068	WASHER #4 INT. LOCK WASHER
54.			
55.	1	40019	GASKET, CASE
56.			
57.	1	55059	SILICONE RUBBER DAMPER
58.			
59.			
60.	1	86484	WIRE HOLD DOWN
61.			
62.	2	95014	SCREW 4-40 x 1 3/8" FH
63.	1	45055	OPEN SENSOR MOUNT

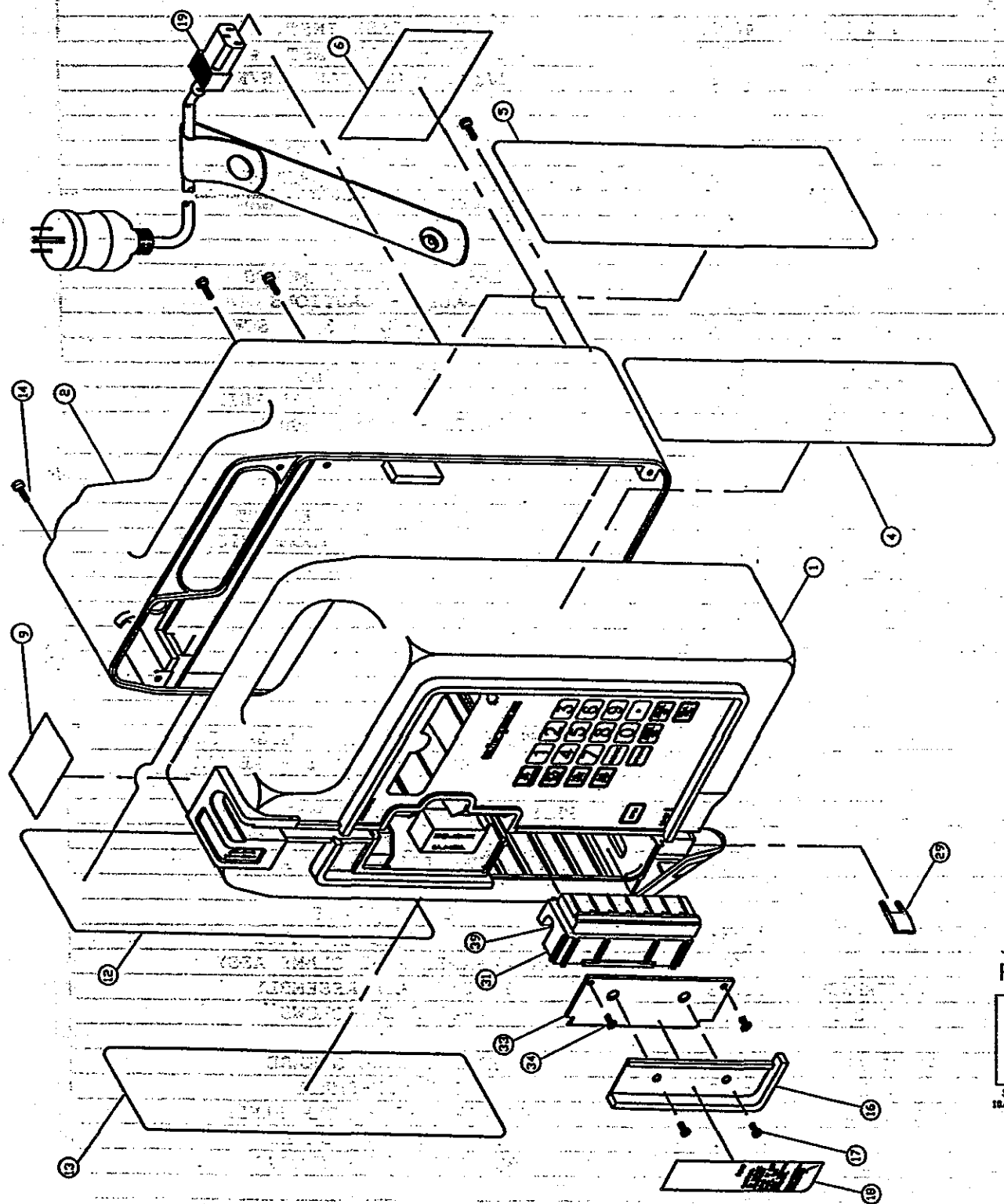


Figure 2.13.1

FINAL ASSEMBLY

TABLE 2.13.2 Revision: E

MODEL 8000 35001 Final Assembly

Bill Of Materials

Item	Quant. BB M B A	P/N	Description
1.	1 1 1 1	35002	FRONT CASE ASSEMBLY
2.	1 1 1 1	35003	REAR CASE ASSEMBLY
3.			
4.	1 1 1 1	40005	LABEL - CASE INST. #1
5.	1 1 1 1	40006	LABEL - CASE INST. #2
6.	1 1 1 1	40015	LABEL - CAUTION / S/N
7.			
8.			
9.	- - 1 -	40010-1	LABEL - TUBE ID BAXTER
	- - - 1	40010-2	LABEL - TUBE ID ABBOTT
	- 1 - -	40010-3	LABEL - TUBE ID McGAW
10.			
11.			
12.	1 1 1 1	40007	LABEL - OPTION MODES
13.	1 1 1 1	40008	LABEL - CAUTIONS
14.	4 4 4 4	95027	SCREW - 6-32 x 3/4" SCKT
15.			
16.	1 1 1 1	45002	ACCESS PANEL
17.	2 2 2 2	95004	SCREW - 2-56 x 3/16" PHIL
18.	1 1 1 1	40011-1	LABEL - ACCESS PANEL
19.	1 1 1 1	35014	CORD SET ASSY
20.			
21.	2 - - -	25311	FUSE 250ma 250V (EXPORT)
	- 2 2 2	25307	FUSE 500 mA 250V (DOMESTIC)
22.	REFERENCE	55009	IN-LINE FILTER
23.			
24.			
25.			
26.			
27.			
28.			
29.	1 1 - -	45052-1	DOWNSTREAM INSERT RIB - McGaw/Braun
	- - 1 1	45052-2	DOWNSTREAM INSERT RIB - AB/BXT
30.			
31.	1 1 - -	35019-1	PRESSURE PLATE ASSY McGaw/Braun
	- - 1 -	35019-2	PRESSURE PLATE ASSY BAXTER
	- - - 1	35019-3	PRESSURE PLATE ASSY ABBOTT
32.			
33.	1 1 1 1	50014	COVER PLATE
34.	2 2 2 2	95032	SCREW 2-56-x 1/4 FHMS
35.	1 1 1 1	35007	BACK PANEL/POLE CLAMP ASSY
36.	REFERENCE	35023	RS-232 JACK ASSEMBLY
37.	2 2 2 2	95020	4-40 JACK SCREWS
38.			
39.	AR AR AR AR	85014	HIGH VACUUM GREASE
40.	10 10 10 10	35117	WIRE TIE-SMALL
41.	REFERENCE	35028	BONDING WIRE - REAR PANEL
42.	REFERENCE	35021	AC INDICATOR CABLE
43.	REFERENCE	35026	BONDING WIRE - KEYPAD
44.			
45.	2 2 2 2	95030	SHOULDER SCREW-SLOTTED HEAD

TABLE 2.13.2 Revision: E
MODEL 8000 35001 Final Assembly
Bill Of Materials

Item	Quant. BB M B A	P/N	Description
46.	2 2 2 2	85149	#5 CURVED WASHER
47.			
48.	- - 1 1	35010	UPSTREAM SENSOR ASSY./ ABB./ BAX.
	- 1 - -	35010-1	UPSTREAM SENMSOR ASSY./ McGaw
49.			
50.	2 AS REQ'D	95113	WASHER .010 THK ONLY USE ONE
51.			
52.			
53.	1 1 1 1	95119	WASHER NYLON
54.	REFERENCE	85240	4-40 X ¼" PHMS (ref. Dwg. 35002)
55.	1 1 1 1	40036	BUSHING MOTOR MOUNT
56.	1 1 1 1	95122	WASHER #6 FLAT
57.	1 1 1 1	85033	SCREW 6-32 x ¼" TRUSS
58.	1 1 1 1	95254	NUT 8-32 SMALL PATTERN
59.	1 1 1 1	86485	CLIP-WIRE
60.			
61.	3 3 3 3	85215	WIRE TIES
62.	1 1 1 1	55002-1	BATTERY ASSEMBLY - HAWKER
63.			
64.	1 1 1 1	40032-2	FOAM PAD - BATTERY
65.			
66.	1 1 1 1	40035	DOULBE SIDED TAPE 1" x 1"
67.	1 1 1 1	85145	LABEL - QA INSPECTION

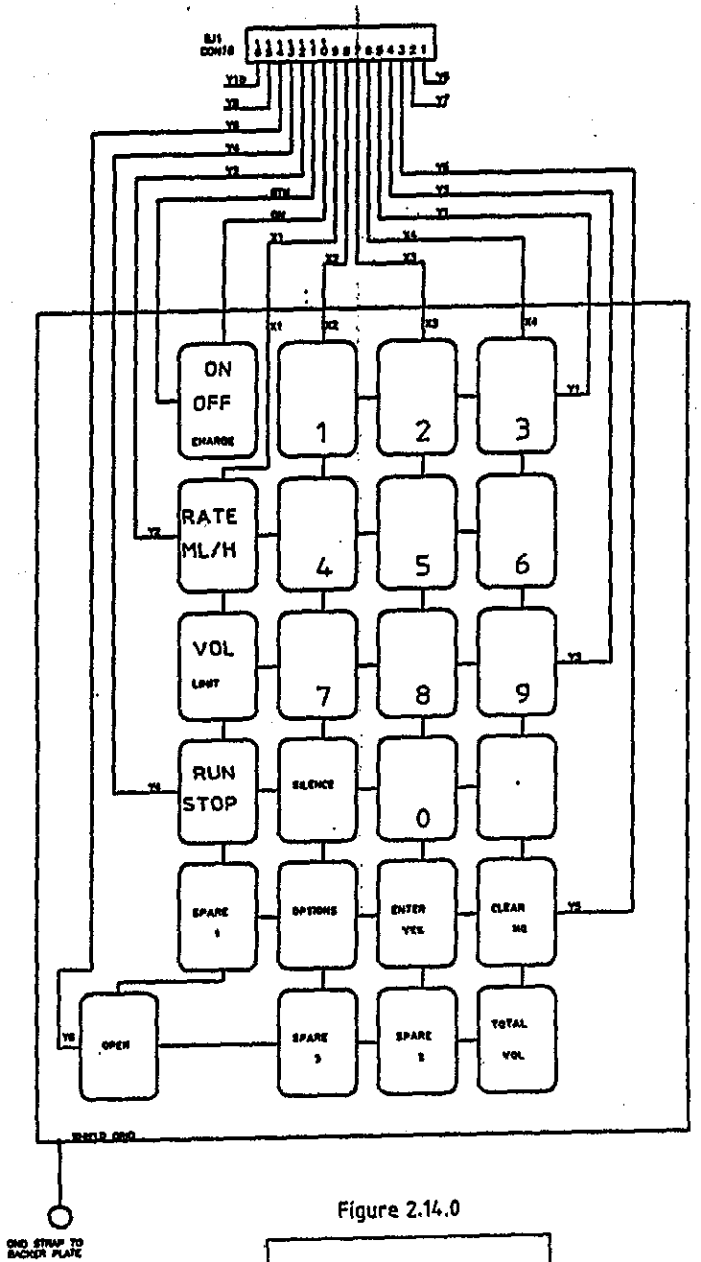


Figure 2.14.0

SCHEMATIC
KEYBOARD

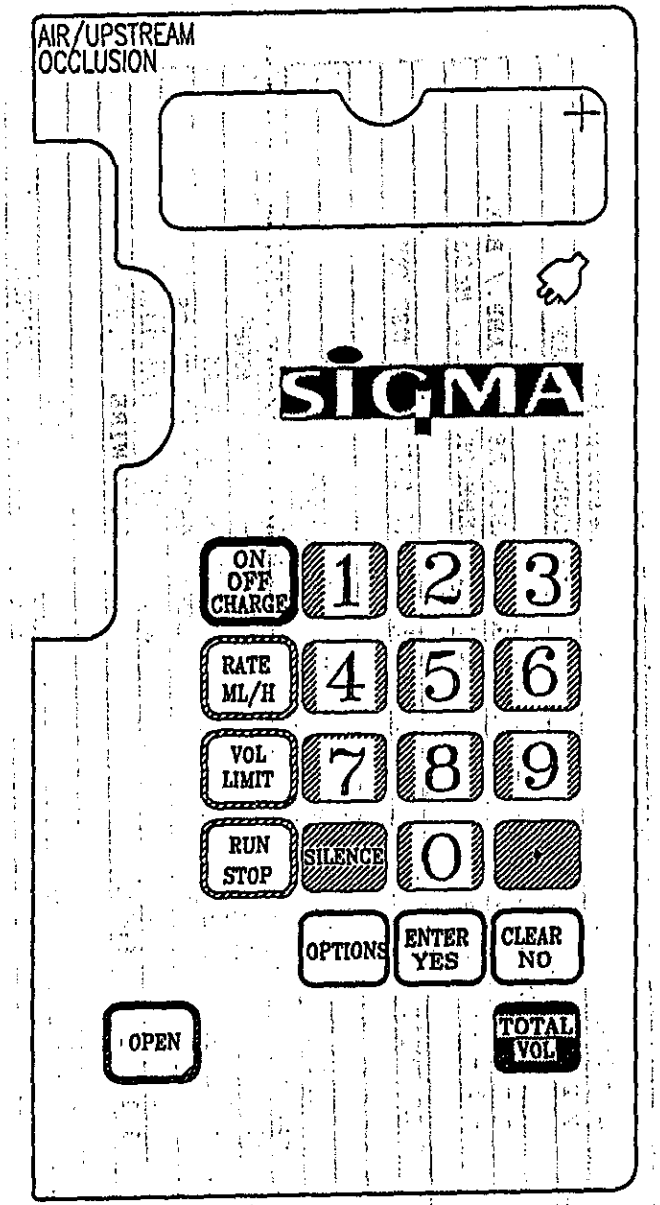
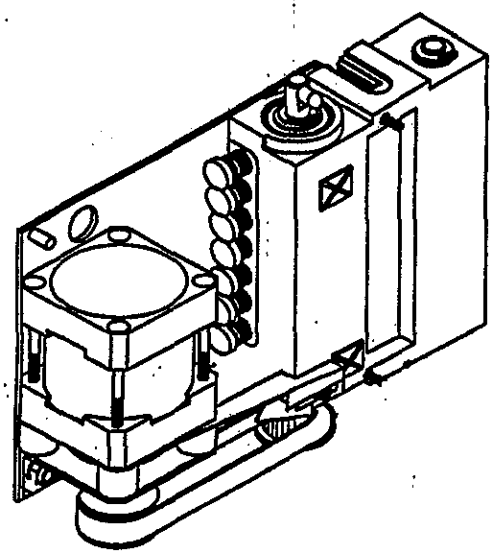


Figure 2.14.1

KEYBOARD
GRAPHICS



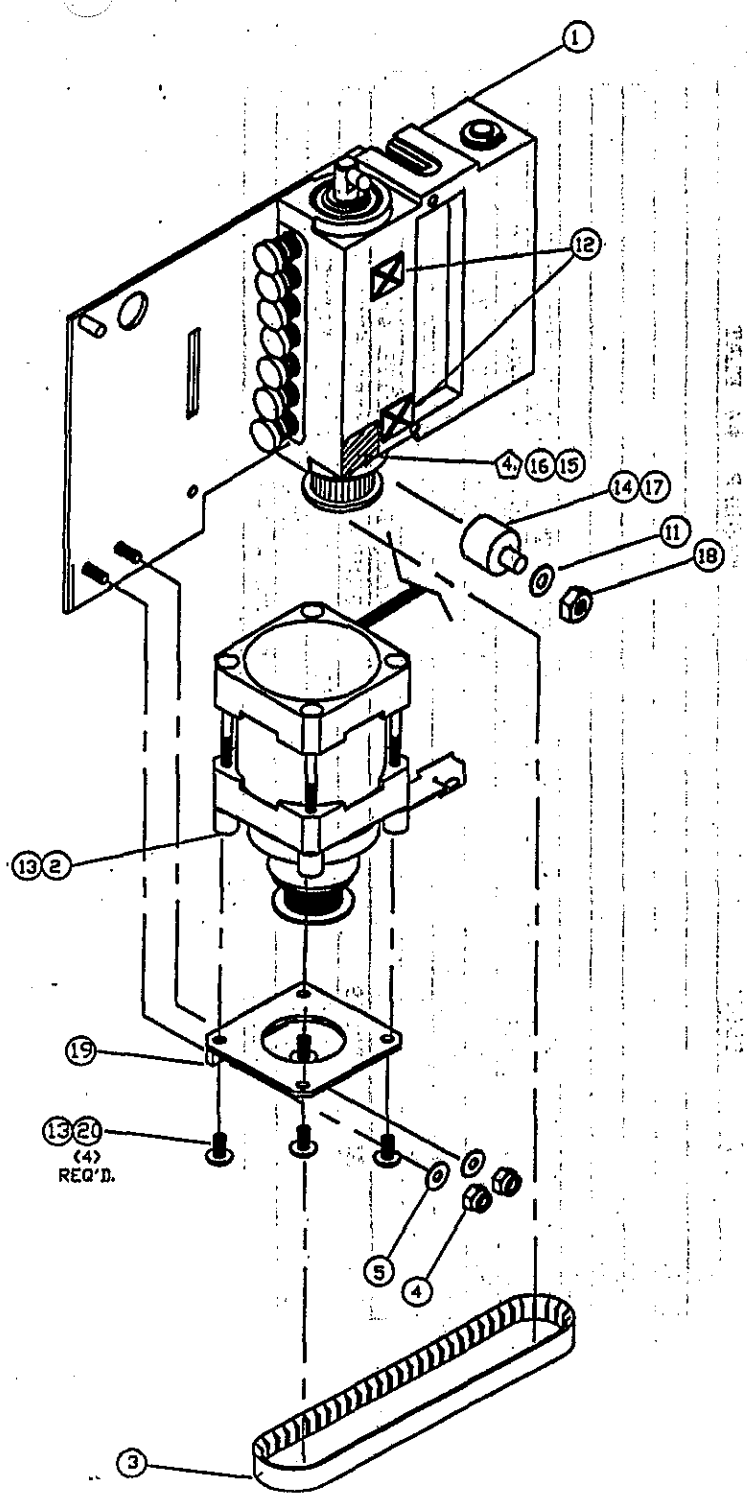


Figure 2.15.1

ASSEMBLY
PUMP/MOTOR

SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 35018.DWG

TABLE 2.15.2 Revision: E

MODEL 8000 Pump/Motor Assembly

Bill Of Materials

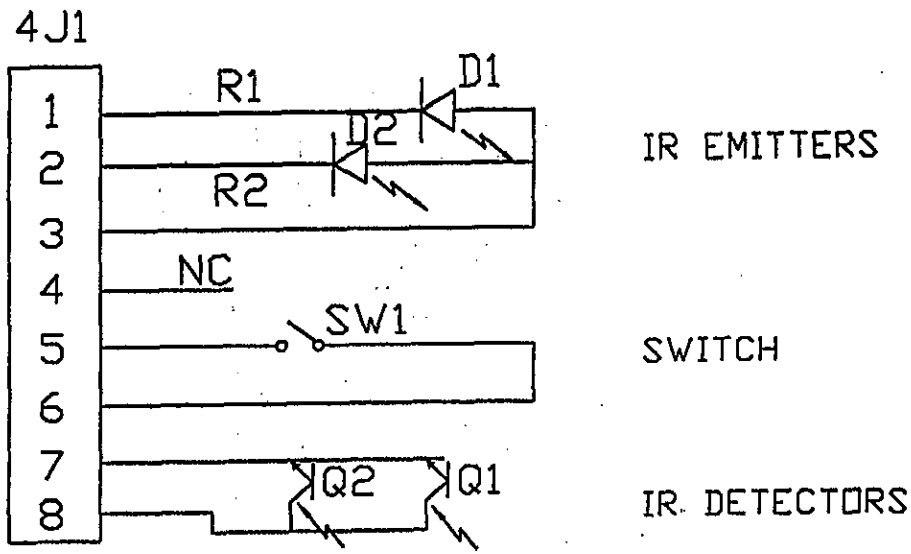
Item	Quant.	P/N	Ref.	Description/Manufacturer
1.	1	35005-1		PUMP SUB ASSEMBLY
2.	1	35004		MOTOR ASSEMBLY
3.	1	55020		MOTOR BELT
4.	2	95153		ESNA NUT
5.	2	85067		WASHER #4 FLAT
6.				
7.				
8.				
9.				
10.				
11.	1	95123		#8 INT. TOOTHSTAR LOCKWASHER
12.	2	86484		WIRE HOLD DOWN
13.	AR	85203		ADHESIVE - LOCTITE #222
14.	1	95019		STUD MOUNT
15.	AR	T106		SANDPAPER (80 GRIT)
16.	AR	85249		ADHESIVE - LOCTITE #406
17.	AR	90029		PRIMER - LOCTITE #770
18.	1	85254		NUT - 8-32 HEX (SMALL PATTERN)
19.	1	50017		MOTOR MOUNT
20.	4	85033		SCREW - 6-32 X 1/4" TRUSS

Figure 2.16.0

ROLLER CLAMP PCB SCHEMATIC

SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 60018.DWG

REVISION RECORD			
SYM	CHG. BY & DATE	CHK. BY & DATE	ECN NO.
E	JH 06/18/99		07299
CHANGE REVISION LEVEL TO MATCH BLANK PCB REV. LEVEL.			

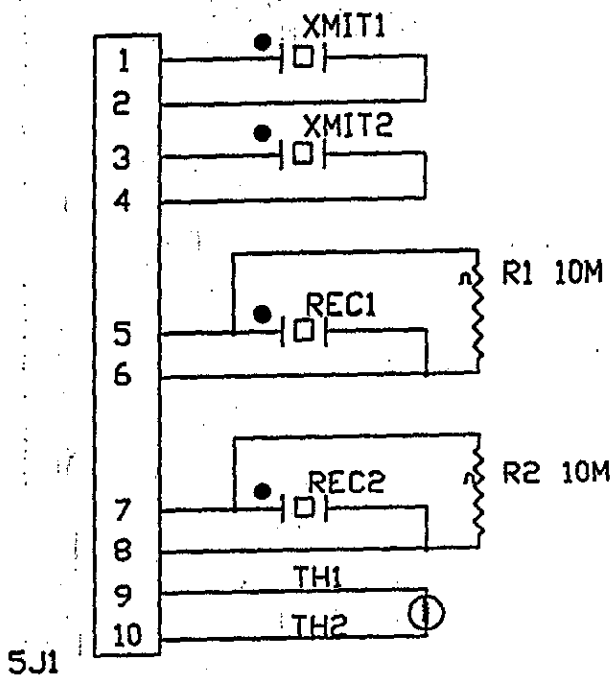


FILE NO.: 60018

DRAWN BY: DDS DATE 07/01/96	TOLERANCES (EXCEPT AS NOTED)	SIGMA INTERNATIONAL, INC. 711 PARK AVE. MEDINA, NEW YORK 14103
CHECKED BY:		
PROJECT ENG.-	DECIMAL ±	TITLE: ROLLER CLAMP PCB SCHEMATIC
MANAGEMENT-		
PRODUCTION MGR.-	FRACTIONAL ±	PRODUCT USED ON: 8000 / SCALE: / NEXT ASSEMBLY: 35011
ENGINEERING DIR.-	ANGULAR ±	DRAWING SIZE: A / DRAWING NUMBER: 60018 / REVISION: E
QA/REG. DIR.-		SHEET 1OF1

DATE	SYM	REVISION RECORD	AUTH	APP.	CK.
7/95	B	MADE SEPARATE DWG			
		ADDED R1 AND R2		DDS	

SCHEMATIC:



FILE: 60019B

DRAWN BY: DDS	TOLERANCES	SIGMA INTERNATIONAL, INC. 711 PARK AVENUE MEDINA, NEW YORK 14103
CHECKED BY:	DECIMAL ±	TITLE: UPSTREAM PCBA SCHEMATIC
PROJECT ENG.:	FRACTIONAL ±	PRODUCT USED ON: 8000 / SCALE: / NEXT ASSEMBLY: 60015
MANAGEMENT:		
PRODUCTION MGR.:		
ENGINEERING DIR.:	ANGULAR ±	DATE: 7-1-96 / REVISION: B / DRAWING NUMBER: 60019
QA/REG. DIR.:		

Figure 2.17.0

UPSTREAM SENSOR PCB SCHEMATIC

SERVICE MANUAL REVISION E
10/22/01 FILE NAME: 60019.DWG

SERVICE MANUAL
SIGMA INTERNATIONAL
MODEL 8000
INFUSION PUMP
SECTION 3

SECTION 3 THEORY OF OPERATION

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3.0 MODEL 8000 INFUSION PUMP THEORY OF OPERATION

3.1 MECHANICAL COMPONENTS

3.1.1 CASE

The Model 8000 Case is a two-piece plastic molding, providing mounting and protection for all of the other components in the Pump. The plastic material chosen for the case provides high strength and a UL Flame Spread Rating of 94V-O.

Refer to Figure 2.0.1 and Figure 2.0.2 for the front and rear Views of the case, respectively.

Case assembly details are contained in:

- Figure 2.11.1, Assembly Drawing, Rear Case
- Table 2.11.2, Bill of Material, Rear Case
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- Table 2.12.2, Bill of Material, Front Case
- Figure 2.13.1, Assembly Drawing, Final /Labels
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3.1.2 BACK PANEL/POLE CLAMP ASSEMBLY

The Back Panel/Pole Clamp assembly is a one-piece aluminum die casting, providing the facility for mounting the Model 8000 Pump on a standard IV pole. The Pole Clamp will accept round poles with diameters between 0.5 and 1.250 inches (12.7 - 31.75 mm), and is secured to the pole by a screw mechanism and hand knob. It acts as a removable cover for access to the battery and is a heat dissipation surface allowing the internal case temperature to be kept below the 105 degree F temperature desirable for reliability. It also provides means for mounting of the PCA syringe holder assembly.

The Back Panel/Pole Clamp Assembly is described in Figure 2.9.1 and the accompanying Bill of Material, Table 2.9.2.

3.1.3 TUBE CHANNEL

The Tube Channel is a slot in the front of the Model 8000 Volumetric Infusion Pump, which holds and acts upon the tubing of the IV set.

Arrayed along the Tube Channel from top to bottom are all of the devices used to monitor and control fluid delivery through the tubing. These include the peristaltic pump assembly and a variety of sensors and mechanical devices essential to operation.

The devices in the Tube Channel are described in the following sub-sections in order from the top of the Tube Channel to the bottom, which is the direction of fluid flow.

3.1.3.1 SYRINGE HOLDER

A molded plastic housing is provided on the top of the case to allow a Luer-Lok (TM) attached to a syringe to be mounted on the Pump.

3.1.3.2 AIR/UPSTREAM OCCLUSION SENSOR

See Schematic, Figure 2.17.0, Assembly.

The Air\Upstream Occlusion Sensor is comprised of a molded plastic housing incorporating two (2) pairs of ultrasonic transducers. The housing is designed to efficiently couple the signals from the transmitters through the I.V. set, and it's contents, back to the receiving transducers.

The tubing in the Tube Channel passes through the Air/Upstream Occlusion Sensor before it reaches the Pump Mechanism. Air bubbles in the fluid are sensed, and if of sufficient size pumping will stop, an alarm will sound and a message will be displayed.

Air bubbles are sensed ultrasonically, by measuring characteristics of the sound waves that travel across the diameter of the tubing. Two sensors are spaced 0.5 inch apart along the length of the tubing, and are used simultaneously to sense bubbles, giving better freedom from false alarms. An air bubble greater than 1 inch (25.4 mm) long, or approximately 100 to 150 microliters in volume, stops the pump and results in an alarm and message display, over the entire range of delivery rates. An equivalent single volume of micro-bubbles or foam in the fluid path is interpreted as a continuous air bubble.

Upstream Occlusions are detected by monitoring the loss in signal strength across both of the sensors. A loss of signal results from the loss of contact pressure between the tube and the sensors due to the negative pressure build up internal to the tube during an upstream occlusion.

3.1.3.2.1 Upstream Air/Occlusion Detection

Upstream air and pressure are measured by two ultrasonic transmit/receive transducer pairs. The two pairs are spaced 0.5 inch apart along the length of the tube channel, allowing the presence of a bubble of this length to be determined.

Air vs. fluid in the tubing is determined by changes in sound transfer characteristics across the tube diameter, indicated by changes in received signal phase and amplitude. A pressure change within the tubing will be reflected by change in the amplitude of the received signal.

Multiple calibration values must be entered to allow for operation of the sensors. There is a frequency setting provided for each of the two transducer pairs, one for pair 1 (upper) and one for pair 2 (lower). Also an air trip threshold and fluid calibration value is provided for each pair. There are calibration values representing relative sensor drive levels, baseline signal levels and other parameters required for overall sensor operation.

The frequency selection is written into the Frequency Register Latch, U31 or U59, from the Aux Bus. The sensor control and drive level are written to U33 in similar fashion.

The frequency value is applied to the "divide by n" input of the respective phase locked loop (PLL), U34 or U57, and causes the voltage controlled oscillator (VCO) to shift until the PLL locks. The VCO runs at twice the transmit frequency. The phase reference stage, U36, divides the VCO frequency by two, and produces a transmit phase reference, whose phase is constant. The reference stage also produces a demod phase reference which may be the same as the transmit phase (0 degrees) or 90 degrees out of phase (90 degrees).

The transmit phase signal excites whichever transmit transducer is selected by turning on its driver (U38 or U39). The final drive stage U65 is powered from the adjustable drive level power supply and drives the transmitting transducer. The demod phase is applied to the reference input of the synchronous demodulator, U40. The level of either 0 degree or 90 degree output from the receive transducer may then be read at Analog input 0, for pair 1, or Analog input 4, for pair 2.

3.1.3.3. ROLLER CLAMP HOLDER

See Schematic, Figure 2.16.0.

The Roller Clamp Holder is a molded plastic housing designed to retain the roller clamp in the pump and house the sensors needed to monitor the presence of the roller clamp and the position of the clamp's roller wheel. The holder is an interchangeable block allowing users the flexibility of using IV sets of various manufacturers, whose roller clamps are of differing sizes.

3.1.3.3.1. Uncontrolled Flow Protection

To install an I.V. set into the Model 8000 Infusion Pump, the roller clamp on the set must first be installed in the Roller Clamp Holder, and the roller must be placed in the closed position. This guarantees that no uncontrolled gravity flow can go undetected prior to the pump being started. The roller must likewise be closed before the tubing is removed from the pump. This assures that no uncontrolled flow is possible during I.V. set removal.

The Tube Channel is locked closed on an installed IV set until the roller clamp is placed in the closed position. This system assures that either a pump finger or a closed roller clamp occludes the tubing to prevent uncontrolled gravity flow through the infusion set. The pump is not allowed to start unless the roller clamp is in the open position, assuring proper fluid delivery.

Three conditions must be met to allow the Tube Channel to be safely opened for unloading or re-priming the IV set, without danger of accidental uncontrolled gravity flow. First, the roller clamp wheel must be closed. Second, the lever locking mechanism must be unlocked. Note in some instances the "OPEN" key on the Keypad must be pressed to do so. Third, the Pressure Plate Release Lever must be pulled open to release the tubing. At this time the IV set may be safely removed from the Tube Channel or the roller clamp may be opened to re-prime the tubing intentionally, under operator supervision.

3.1.3.3.2. Roller Clamp Sensing

Sensors monitor the presence of the clamp and the position of the roller. The presence of the Roller clamp is detected by a switch contact closure. Roller position is sensed with two Infrared Emitter/Detector pairs, one pair at both the open position and the closed position of the roller wheel.

The LED emitter current is chopped at 16.384 kHz to distinguish the infrared beam from room light. The phototransistor IR detector drives a tone detection circuit tuned to the chopping frequency, which changes the output state when the beam is broken.

The three IR LED emitters are driven singly by sections of U27, a high-current tri-state buffer, whose signal inputs are connected to a 16.384 kHz signal divided from the processor clock. The enable inputs for U27 are decoded from two Processor output lines by U22A. The program selects one LED and then monitors the CLAMP O/S output of tone detector U29.

The roller-closed state is determined reflectively, so the CLAMP O/S signal will be low to indicate the presence of the syringe or roller. Roller open breaks the beam, producing CLAMP O/S high to indicate roller presence.

The tone detector is tuned to twice the chopping frequency, or 32.768 kHz, to allow its phase-detector to work.

3.1.3.4 PUMP ASSEMBLY

The Model 8000 Volumetric Infusion Pump utilizes a linear peristaltic pumping mechanism. Pumping action is effected by inserting the tubing of an IV set into the Tube Channel and closing the pressure plate on the tubing. The pressure plate maintains the tubing in close contact with the peristaltic pump fingers, allowing the progressive tubing occlusion necessary to the pumping action.

The pumping mechanism assembly is described by figure 2.10.1, and Table 2.10.2 the accompanying Bill of Material.

3.1.3.4.1 Peristaltic Pump Fingers and Pressure Plate

When the tubing is loaded in the peristaltic pumping mechanism, a pressure plate forces the tubing into contact with the tips of the pump fingers. The fingers move sequentially toward the pressure plate, progressively compressing the tubing into occlusion, and forcing the trapped fluid downward. As the last (bottom) finger finishes its compression cycle and begins to retract, the first finger has reached occlusion trapping the next quantity of fluid and starting the next pumping cycle. Flow is effectively continuous.

The sequential motion of the fingers is controlled by a camshaft comprised of seven eccentric cams; each offset rotationally from its neighbors by 1/6 of a revolution.

3.1.3.5 DOWNSTREAM OCCLUSION SENSOR

Downstream occlusion is detected by measuring fluid pressure for a rising pressure trend during pumping, indicating blockage below the pump. If the pressure rises, a downstream occlusion alarm message is displayed, and pumping is suspended.

3.1.3.5.1 Downstream Occlusion Sensing

Internal tubing pressure is sensed below the pumping area of the Tube Channel. If the pressure between the pump and the patient catheter is found to be rising an appropriate occlusion alarm message is displayed, and an alarm sounded, alerting the user to total obstruction of the fluid path.

The Pump stops and remains stopped, until the cause of the occlusion is removed and the measured pressure is reduced, allowing the delivery to resume automatically.

Downstream pressure is monitored by the Downstream Pressure Transducer, which is a piezo resistive bridge transducer. The transducer is excited with a DC reference of 4.0 volts (U42A). A differential amplifier with a gain of 260 (U42B), boosts the signal level of the transducer, and feeds the signal to Analog input 2 of the Processor.

3.1.3.6 PRESSURE PLATE RELEASE LEVER

The Pressure Plate Release Lever is pulled open to move the pressure plate away from the pump fingers, allowing tubing to be installed in, or removed from, the Tube Channel. The roller clamp must be installed and in its closed position to allow the Lever to be opened, for removal of the tubing, otherwise, the Lever remains locked and closed at all times when the tubing is sensed in the pump.

3.1.4 STEPPER MOTOR AND DRIVE BELT

See Assembly, Figure 2.7.1, Bill of Material, Table 2.7.2, Assembly, Figure 2.15.1 and Bill of Material, Table 2.15.2.

The pump assembly camshaft is rotated by a Stepper Motor, through a cogged drive belt and cogged pulleys. The Motor allows the camshaft to be rotated throughout the rate range, by increments of 260 motor steps per pump revolution or multiples thereof. Because the motor step rate is derived by the Processor from its crystal controlled clock, the motor rotation rate is constant to near the error of the crystal. Error is less than +/- 0.1% for all sources of error.

3.1.4.1 MOTOR

The Motor is a two-phase, 1.8 degree stepper motor. It is coupled to the pumping mechanism through a glass-reinforced timing belt and cogged pulleys. The pulley drive ratio is 1.3 : 1, thereby making the motor make 260 steps (1.3 revolutions) per one revolution of the pump.

3.1.4.2 MOTOR DRIVER

The Driver Circuit for the Motor is located on the Processor Board. Constant current phase drive for the motor coils is provided by a switched-mode, full-bridge motor drive circuit.

3.1.4.3 STEPPER MOTOR CONTROL

The Stepper Motor Control consists of two functions contained in two IC packages. U9 is a dual, seven-bit plus sign, Digital-to-Analog converter, which translates data from the system bus to two analog voltages. The analog voltages determine the motor phase current produced by the pulse width modulated current limiters in the dual motor driver, U8. Sign bits from the A/D determine the polarity of the motor current.

Motor rotation and torque are determined solely by the sequence and amplitude of the voltages written by the Processor to the D/A converter of the control IC. If the Processor fails, the motor stops.

3.2 ELECTRONIC COMPONENTS

3.2.1 FUNCTIONAL BLOCKS

3.2.1.0 BLOCK DIAGRAM AND CABLING DIAGRAM

A Block Diagram showing a simplified interconnection of all of the Functional Blocks which make up the Model 8000 Volumetric Infusion Pump is found in Figure 2.1.0.

A more detailed description of the actual Printed Circuit Boards, Components and Interconnections is contained in Figure 2.2.1, Cable Diagram.

The two of these diagrams together describe the signal/data flow within the Model 8000, as well as which cable, connector and boards are associated with a certain function.

The Model 8000 circuitry is seen to reside on five printed circuit boards, specifically, the Transformer Board, the Regulator Board, the Display Board, the Sensor Board and the Processor Board. Each of these is discussed in general in this section and in more detail in the associated sub-sections.

3.2.2 TRANSFORMER PCB/AC LINE CIRCUIT

See Schematic, Figure 2.3.0, Assembly, Figure 2.3.1 and Bill of Material Table 2.3.2.

3.2.2.1 LINE CORD

Power is supplied to the pump through a Hospital Grade plug and line cordset. The cordset is terminated at the chassis in an A.C. input receptacle, allowing the cordset to be replaced if damaged. The pole clamp assembly is provided with a mechanical retention device, preventing removal of the line cord from the Pump, except with a screwdriver, to prevent accidental loss of the line cord.

3.2.2.1.1 LINE CORD AND INPUT VOLTAGE SELECTOR

Power from the AC line enters the Model 8000 Infusion Pump through the line cord and A.C. Power Entry Module, as shown on Figure 2.2.1, the Cable Diagram. The AC line connection to the Transformer Board is made through 7W1, the brown "line" wire and 7W2, the light-blue "neutral" wire. These connections are made with double insulated wire.

On entering the Transformer Board, line power is applied to the Voltage Selection connectors, as seen in the Schematic. If no jumpers are installed (fixed jumper traces are present) it results in parallel excitation of the dual transformer primary, for operation on 120 volts RMS nominal line voltage. Operation on nominal 240 volts RMS lines is possible by removing the fixed jumper traces and installing a jumper as seen on the schematic which selects series connection of the dual primary.

Fuses in the A.C. Power Entry Module must be selected for compatibility with the line voltage operation selected. Line fuses are as follows:

Fuses may be replaced only with the following parts:
For 120 Volt operation: Littelfuse 218.500 (0.5A FB)
For 240 Volt operation: Littelfuse 218.250 (0.25A FB)

Substitution of other fuses violates the Medical Device Certification of this Product, and may compromise Product Safety.

3.2.2.2 A.C. INLET MODULE, FUSES

The A.C. Power Entry Module provides a chassis receptacle to allow for easy replacement of a damaged AC line cordset, houses the line fuses and provides a filter for control of line conducted interference into and out of the Pump chassis. Both Line and Neutral conductors from the Line Cord are fused, in accordance with IEC safety requirements.

Fuses may be replaced only with the following parts:
For 120 Volt operation: Littelfuse 218.500 (0.5A FB)
For 240 Volt operation: Littelfuse 218.250 (0.25A FB)
Substitution of other fuses violates the Medical Device Certification of this Product, and may compromise Product Safety.

3.2.2.3 POWER TRANSFORMER

AC Line power enters the Pump through a 50/60 Hz, dual primary, double-bobbin wound Power Transformer. The Power Transformer steps the line voltage down to a low AC voltage, nominally 24 vrms, for rectification, filtering and subsequent regulation. The Power Transformer is mounted on the Transformer Printed Circuit Board, described further in Section

The Power Transformer is wound on double bobbins to guarantee minimum risk leakage current, maximize breakdown voltage and provide fault current creepage distance in accordance with the safety requirements of IEC Standard 601-2, CSA C22.2-125, and UL 544. The Transformer contains internal thermal cutouts to limit temperature rise in the case of a short circuit fault, either within the transformer or in the associated circuitry. Accordingly:

The Power Transformer may be replaced only with a CSA approved replacement transformer (Sigma p.n. 55001). Substitution of another transformer is a violation of the Medical Device Certification of this Product, and may compromise Product Safety.

3.2.2.4 SECONDARY VOLTAGE AND POWER INDICATOR

The secondary voltage of the Power Transformer is nominally 24 volts, and powers the Model 8000 through 7W3 and 7W4. Presence of AC power is indicated by energizing a light-emitting diode (LED) on the front panel. The small current required for the LED is supplied by D1, R1 and R2, and is a half-wave rectified, pulsating DC of less than 10 mA average current, or less than 20 mA peak.

Fuse F1 protects the transformer in the event of a catastrophic overcurrent drawn from the secondary. This fuse will ordinarily never need to be replaced and in the event that it opens, a seri failure elsewhere is indicated. Return the equipment for factory service if F1 opens, unless the reason for its failure is known certain (i.e. an accidental short circuit during maintenance).

3.2.3 REGULATOR PCB/BATTERY CIRCUIT

See Schematic, Figure 2.4.0, Assembly, Figure 2.4.1, and Bill of Material, Table 2.4.2.

3.2.3.1 RECTIFIER, FILTER, REGULATOR

Low voltage AC from the power transformer secondary enters the Regulator Board at 6P1, and is rectified by bridge rectifier, D8. The raw DC is filtered by C16. The raw DC may vary between 22 to 39 Volts DC, and contain up to 4 Volts p-p of ripple, depending upon line and load.

A switched-mode, buck-topology regulator, U1, steps down the raw DC voltage to a nominal value of 15 volts. Due to component variations, the actual value of the regulated voltage may be between 14.9 and 16.2 volts. C10 - C15 provide low impedance decoupling for the switching ripple current of U1, which switch at 100 kHz. L1 is the filter inductor and D3 is the output catch diode for the regulator. R4 and R5 are the feedback resistors, which set the output voltage of the regulator. Filter capacitors C4 - C9 minimize ripple on the output voltage. Details of the operation of U1, a Linear Technology LT1076, may be found in Linear Technology Application Note 44.

The regulated 15 volts is summed with the battery voltage in diodes D4 and D6, to form the motor voltage supply, labeled VMOT. Diode summing allows the battery to take over instantly upon loss of AC line voltage, and the battery to begin recharging immediately upon restoration of line voltage.

3.2.3.2 LOGIC VOLTAGE SUPPLY AND SWITCH

Supply voltage for the 5-volt logic in the Model 8000 Infusion Pump is regulated by a three-lead switching regulator, the Power Trends 78SR105, designated U2. The device is similar to the regulator described for the 15-volt supply, but all of the parts are contained in a single package. The switching frequency is 650 kHz, allowing a small inductor to be used.

Field effect transistor Q1 allows the logic supply to be turned on or shut off electronically from the processor board. This action may originate from the keyboard, the roller clamp or within the program. The keyboard switch may turn the power on or signal the microprocessor to turn the power off. The roller clamp may only turn power on (upon installation), while the program may only turn power off (in the event of low battery voltage or an OFF key actuation). A low level applied to the gate turns Q1 on.

3.2.3.3 Battery Charger

The Battery is a 12-volt lead-acid storage battery with a 2.5 Amp-hour capacity. When a new battery is fully charged, the battery will power the Model 8000 Infusion Pump for a minimum of 4.5 hours. The Battery is considered to be exhausted when its loaded voltage drops to 10 volts, at which time the system shuts down to prevent damage to the battery.

An exhausted battery begins to charge as soon as the line cord is plugged in. Q3 is biased on by R9 and R10, and draws a collector current of 10 mA through D2. The voltage drop of GaAs LED D2, roughly constant at 1.5 volts, forward biases the base of PNP transistor Q2. Because Q2 attempts to maintain a voltage of 0.9 volts (1.5-Vbe) across the emitter resistor, R6, the emitter current and therefore the collector current are constant. Q2 thus acts as a constant-current source charging the Battery, at a current of around 250 mA, or C/10, for the 2.5 Ah Battery.

Battery voltage is sensed by divider network R11, R12 and R13. D5 prevents discharge by the divider when line voltage is not connected. When the wiper of R12 rises to 2.5 volts, adjustable zener diode D7 draws anode current, partially shutting off Q3 and Q2, terminating constant current charging. The collector of Q2 then maintains a set voltage, charging in constant voltage mode until full charge is obtained.

R12 allows the constant voltage of the charger to be adjusted between 13.8 and 15.1 volts, accommodating the charging voltage needs of various batteries.

3.2.3.4 BATTERY PACK

Six (6) D-Cell starved electrolyte sealed lead acid storage batteries provide 4.5 hours of pump operation when fully charged. This can be used for either standby or portable operation.

3.2.3.5 REGULATOR PCB

Low-voltage AC from the Power Transformer is rectified to DC, filtered and voltage regulated by the Regulator Board. Regulation occurs in two steps.

A switched mode pre-regulator drops the voltage of the filtered DC to an intermediate level suitable for operating the pump motor and charging the battery. The battery is charged by the current-limited, constant-voltage technique at a rate of C/10. The motor is driven with a constant-current, switched-mode motor driver.

A second switched mode regulator provides the logic power voltage from the intermediate supply voltage.

3.2.4 DISPLAY PCB/AUXILIARY BUS

See Schematic, Figure 2.5.0, Assembly, Figure 2.5.1, and Bill of Material, Table 2.5.2.

3.2.4.1 DISPLAY PCB

The Display is made up of two, side-by-side, four- character, alphanumeric Light Emitting Diode Data Display Circuits, for a total of eight characters. Each LED matrix is 6.9 mm high (0.27 inches), and comprises a 5 (horizontal) by 7 (vertical) dot matrix. LED color is green. The display has the capability of 128 ASCII characters.

Details of the Display Board Assembly are found in Figure 2.5.1 and Table 2.5.2.

All data reports, alarm messages and user operating prompts (instructions) appear on the Display.

3.2.4.2 DISPLAY/AUX BUS INTERFACE

The data is transmitted from the Processor Board to the Display Board via a 20-conductor, 8-bit parallel data bus. The bus contains four address bits and two device select lines, allowing up to 32 read/write data locations to be defined. The Display Board utilizes nine locations, one for each of the eight characters, and the ninth for a bidirectional control register. The data bus connects to 3J1.

The Power Indicator LED is also housed on the Display Board, connected to 3J2. The LED illuminates the power indicator on the Keyboard whenever the AC line cord is plugged in.

3.2.4.3 LED Displays

The Display Board holds two, 4-character ASCII Alphanumeric LED Data Displays. Each Character is made up of a 5x7 matrix of green light emitting diodes. Characters are 0.27 inches high and spaced on 0.25 inch centers. Any of 128 ASCII characters may be written to the display, in any of the eight character positions, in random order.

3.2.5 SENSOR PCB

See Schematic, Figure 2.6.0, Assembly, Figure 2.6.1, and Bill of Material, Table 2.6.2.

The Sensor Board provides additional printed circuit board area to house the interface circuits for the temperature, air, roller clamp, drop/flow and pressure/occlusion sensors. Each of these sensors operation depends upon a transducer element to change the physical quantity being measured into an electrical analog voltage, along with circuitry to standardize the voltage for use by the processor. Each of these is discussed in its respective sensor section elsewhere in this theory of operation.

3.2.6 PROCESSOR PCB

See Schematic, Figure 2.6.0, Assembly, Figure 2.6.1, and Bill of Material, Table 2.6.2.

The Processor Board contains the 68HC16 Microprocessor and the Random Access Memory (RAM) and Programmable Read Only Memory (Program PROM) necessary to run the control program of the Model 8000 Infusion Pump. In addition, the Keyboard Interface, Display Interface, Motor Controller and Speaker Driver occupy the Processor Board.

3.2.6.1 Microprocessor

Central to the operation of the Model 8000 Infusion Pump is the Motorola MC68HC16Z1 Control Adapted Microprocessor (see Figure 2.6.0). The internal makeup of the 68HC16 includes a 16-bit processing unit, capable of clock rate as high as 16 MHz, surrounded with an array of counters, timers, analog-to-digital converter, general purpose input/output, multi-priority interrupts and data bus interface. The 68HC16 is housed in a 132-pin Plastic Surface Mount Package, Designated UNN1 on the Assembly Drawing, Figure 2.6.1. The 68HC16 is seen to occupy the center of sheet 1 on the Schematic, surrounded with peripheral circuits providing the functions necessary for operation of the Model 8000 Infusion Pump.

Starting at pin 1 of the 68HC16 Processor and following the pin numbering counter-clockwise, operation of the processor may be discussed. Detailed descriptions of the other parts on the Processor Board will follow. Pin 3 is the output of a timer set to the frequency of the alarm tone. The tone is a square wave and drives the alarm volume control IC, U7. Pins 6,7 and 127 are I/O pins used to increment and decrement the volume control, U7.

Pins 4,5,13 and 14 are outputs. Pin 4 controls the Staff Call circuit, pin 5, the DC On/off function and pins 13 and 14, device selection for the Syringe and Roller Clamp Sensors.

Pins 10, 11, 12, 15 and 16 are used to form the Queued Serial Bus for the serial EEPROM and the RTC.

The Serial Receive Data and Transmit Data occupy pins 17 and 18, and drive the Serial Communication Interface, U49.

Pins 19 through 39 form the System Address Bus, A18- A1. A18 is unused, while A0 originates on pin 90.

The Analog Inputs, with eight separate A/D converter channels and reference voltage inputs occupy pins 42 through 53.

Standby voltage from the lithium Backup Battery is applied to pin 54. This source also maintains the Real Time Clock when power is shut down. The battery is protected from chance contact with other voltage sources by D1 and from short circuits by R3. Projected battery life for the Lithium Battery is at least four years of continuous backup, probably nearer five or six years with normal use, since the battery is not consumed while unit power is on.

The 32,768 Hz clock input is on pin 57. Decoupled power for the internal clock synthesizer is supplied through pin 56. The phase detector filter capacitor for the synthesizer is connected at pin 60. The internal clock frequency is set by the program by the values loaded into the synthesizer dividers. The synthesized clock frequency may be monitored at pin 63 of the Processor, or on 1J9-14.

The External Debugging Port occupies pins 63 through 71 of the Processor, and are available at the Test Port Connector, 1J9. This port is intended to allow access to the processor for test and calibration purposes, under the control of a PC.

The Lever latch is controlled by pin 73, configured as an output, while the status of the Lever is monitored by pins 72 and 79 configured as inputs.

System interrupts are applied to the processor on pins 75 through 78. Interrupt acknowledges return on pins 119 through 123.

The Write line is on Processor pin 80. Pin 81 through pin 89 and 182 to 131 are used as miscellaneous Input Port lines, for example, monitoring the status of the PCA input and flow detector installation. Most of the Input port is spare.

The balance of the Processor pins are devoted to Data Bus (Pin 91 to pin 109) and Device Select Lines (Pin 110 to pin 118).

3.2.6.2 POWER SWITCHING CONTROL

The power switching control allows the DC power to the Model 8000 Infusion Pump circuit boards to be turned on or off electronically. U19 is powered from the standby supply, VSTBY, continuously. Operating the On/Off key on the keyboard, or installing a roller clamp, grounds one of the inputs to U51 (A), forcing the output high. The clock input of U19 (A) rises and the flip-flop toggles, turning on Q2, Q13, Q14 on the Processor Board and Q1 on the Regulator Board. Logic power and motor power are thus applied to the circuitry.

The output of U51 (A) is applied to the set input of U19 (B) which will turn off the alarm backup power U54 had it previously been turned on by the supervisor circuit. Operating the On/Off key again has no further effect upon U19, but signals the processor through the keyboard encoder that the power should be turned off. The microprocessor will then apply a low level to U20 pin 5 and through U51 clears the output of U19 (A) turning Q2 off and shutting off the power to the circuitry. The !PWROFF signal from the processor allows the processor to turn power off, but logically can not turn power on when it has no power. Q14 switches current-limited battery power to the voltage divider made up of R88, R89 and R90. The divider allows the processor to monitor the battery charge state at Analog Input 5. Shutting off the divider prevents discharging the battery during storage, if the line cord is not plugged in. 1J1 connects the Processor Board to the power harness.

3.2.6.3 STATIC RAM AND PROGRAM PROM

Program storage occupies U2, the Programmable Read Only Memory (PROM). The PROM is organized as 65,536 words (128k bytes) of 16 bits, and may be doubled to 131,072 words (256k bytes) by installing a more dense memory package. Because the processor reads program memory by word, the byte control bit of the address (A0) is not used on the PROM. PROM chip select (!PCS)is derived from the !CSBOOT line of the Processor.

Data storage is accomplished by U1, the Static Random Access Memory (SRAM). The SRAM is organized as bytes of 8 bits, addressed as bytes (by A0), with a capacity of 131,072 bytes (128k bytes) in a 32-pin SOIC, or 65,536 bytes (64k bytes) in a smaller 28-pin SOIC. Although the program may never need the storage capacity of either of these packages, they are the industry standards, and the migration path is provided so that the product life time of the Model 8000 is not dictated by the seemingly rapid component turnover in the IC industry.

3.2.6.4 ELECTRICALLY ERASABLE PROM

Electrically Erasable Programmable Read Only Memory, or EEPROM, provides the Model 8000 with a medium for the storage of data which must be changed on occasion, but maintained most of the time. This might include pump configuration data or the history buffer log.

EEPROM is read or written by the processor through the Queued Serial Bus. Data to the EEPROM is applied to U15-3, the Data In line of the EEPROM from UNN1-11, the MOSI line of the Processor. Returning data, on the MISO line, moves from U15-4 to UNN1-10. The Processor clocks the data transfer by pulsing UNN1-12 and U15-2. The EEPROM select is decoded by U22-10, from the states of UNN1-15 and 16.

3.2.6.5 RTC/Clock and Supervisor Circuit

The Real Time Clock, U4, provides the Model 8000 with a time of year timekeeping function, so that the history log may be time-stamped. Time is maintained during unpowered storage by the lithium back-up battery. The 32.768 kHz clock for the Processor is supplied by the RTC, when the +5-volt logic power is turned on, and the power-up reset is asserted until the logic supply has been stable for about one second.

Time is read or set by the processor through the Queued Serial Bus. Data to the RTC is applied to U4-5, the MOSI line of the RTC from UNN1-11, the MOSI line of the Processor. Returning Data, on the MISO line, moves from U4-6 to UNN1-10. The Processor clocks the data transfer by pulsing UNN1-12 and U4-4. The RTC select is decoded by U22-11, from the states of UNN1-15 and 16.

The processor must pulse the RTC select line every 200 ms (5 PPS) to prevent the Supervisor Circuit from sounding an alarm and shutting off power to the micro processor. This audio is an indication of processor failure, produced by counter U16, which continuously counts the independent 32 kHz clock. A pulse on the RTC select line is synchronized with the clock by the two flip-flop stages U17B and U18A, and applied to the counter reset. Failing to reset the counter will start a pulse modulated 2 kHz tone at 2 bursts per second, within 250 ms of the last reset pulse.

3.2.6.6 Analog Input Channels

Eight Analog-to-Digital Converter Inputs give the Processor access to the analog signals necessary to the operation of the Model 8000 Infusion Pump. A 4.096 volt reference is established for the A/D Converters by adjustable zener diode, D14. This also serves as the excitation source for the Thermistor (TH1).

Analog inputs are assigned as follows:

- **Analog 0, Air/Upstream Occlusion, Sensor 1**
- **Analog 1, Temperature (Thermistor, TH2)**
- **Analog 2, Downstream Pressure**
- **Analog 3, DS Occlusion Supply (.5Vex)**
- **Analog 4, Air/Upstream Occlusion, Sensor 2**
- **Analog 5, 12V Battery Voltage (.2VBAT)**
- **Analog 6, Temperature**
- **Analog 7, Motor Supply Status, AC Line Status (.2SWVMOT)**

3.2.6.7 PUMP TEMPERATURE

The pump temperature is monitored by U69 on the Processor PCB. The alarms that may occur due to a temperature change are as follows:

LOW TEMP: The pump's temperature sensor has detected that the pump temperature is below 40°F. Allow the pump to reach a minimum of 68°F before subsequent operation. This alarm will reset when temperature goes above 40°F.

HIGH TEMP: The pump's temperature sensor has detected that the pump temperature is above 150°F. Allow the pump to return to below 85°F before subsequent operation. This alarm will reset when temperature goes below 150°F.

3.2.6.8 SPEAKER DRIVER/VOLUME CONTROL

The alarm tone originates as a square wave output from UNN1-3, which is the output from one of the timer functions of the Processor. The Tone is applied to the high end of U7 (Pin 3) which is a CMOS electronic voltage divider. U7 operates analogously to a manual volume control, but the control rotation is replaced by an electronic counter turning field effect transistors on and off, to change the resistance of a 100-step resistor divider.

The sign of the volume change (increase or decrease) and slope of the change (how quickly it changes) are controlled by three outputs from the Processor.

The alarm tone is amplified and applied to the speaker by power amplifier U8, as is the supervisor tone when active.

3.2.6.8.1 SPEAKER

A 1-inch, plastic cone speaker allows the Model 8000 Infusion Pump to alert an operator to a malfunction via an auditory alarm.

The audible alarm tone accompanies all displayed alarm messages. Tone volume is selectable by the user, with a key sequence on the Keypad. The tone may be silenced for a period of two minutes from the Keypad, while the alarm message continues to be displayed.

3.2.6.9 DISPLAY/AUXILIARY INTERFACE

The Display/Auxiliary Bus is a general purpose, eight-bit extension of the system data bus. Eight bi-directional data lines are buffered by U14 allowing data to be written or read on the Aux Bus, by the Processor. Four address lines and two device selects are buffered by U13, allowing thirty-two locations to be defined on the bus. There is also an interrupt level (IRQ4) assigned to the Aux Bus.

The Display/Aux Bus is presently used for the Display Board and the Sensor Board.

3.2.7 KEYBOARD

The Keyboard is a 21 position membrane keyswitch matrix. The surface of the Keypad is PET Polyester film, providing resistance to all common hospital cleaners and disinfecting solutions.

Details of the Keyboard Assembly and functional key assignments may be found in Figure 2.14.0, Schematic, Figure 2.14.1, Keyboard Assembly Drawing and Table.

3.2.7.1 KEYBOARD INTERFACE

A keyboard of up to 40 keys, in a 4-by-10 key matrix, may be accommodated by the keyboard encoder comprised of U10 and U12. The 74C923, U10 is the Keyboard Encoder proper, and converts a single key closure in the x-y switch matrix into a binary code which is presented to data buffer U11. Key bounce and multiple closures are eliminated by U10. Five additional "y" inputs are added to the switch matrix by U12, doubling the capacity of the Encoder from 20 keys to 40 keys.

When a key is pressed, the Encoder, U10 begins a time out to allow the key to stop bouncing. At the end of the time-out, the key code appears at the outputs, and the data available line (U10-13) rises. The rising data available line sets flip-flop U18A, entering an interrupt on the IRQ3 level. When the Processor responds to the interrupt, the acknowledge line, IACK3, falls and clears the interrupt. The processor then reads the keycode data by asserting DSEL2, strobing the data onto the system data bus via U11.

3.2.8 TEST PORT, SHAFT SENSOR, FLOW SENSOR, and LEVER LOCK CONTROL

See Assembly, Figure 2.8.1, and Bill of Material, Table 2.8.2.

The Test Port, 1J9, contains all of the signals used by the MC68HC16Z1 Processor for its internal debugging mode. The intention is to allow access to the processor via a PC terminal, for automated test and calibration procedures.

The Shaft Sensor is a magnetically activated Hall- effect device, which produces one pulse for each rotation of the pump shaft. The sensor pulse sets flip-flop U5A, entering an interrupt on IRQ1. The processor clears the interrupt by asserting IACK1, and enters any operation dictated by the interrupt service routine. Monitoring pump rotation allows the processor to determine whether the pump has stalled due to a broken belt or other reason.

The flow sense signal produces a similar response on U5B, IRQ2 and IACK2.

The Lever Release Solenoid is controlled from Processor output PF6, UNN1-73, which drives a high current switching FET, Q12. Energizing the solenoid opens the Lever lock, allowing the Lever to open.

The status of the Lever is monitored by two Hall-effect devices, through Processor inputs and PF7, pins and UNN1- 72, respectively.

3.2.9 BACK PANEL/SERIAL INTERFACE CONNECTOR

A 9-pin, D-subminiature connector located on the rear panel of the pump provides for connection of devices to access various input and output functions of the pump. Accessories and options include an opto-electronic flow detection device, a nurse call output, an RS-232 based serial data interface and planned future expansion options.

3.2.9.1 FLOW SENSOR AND INTERFACE

The Flow Sensor which connects to the SIGMA 8000 attaches to the drop chamber of the I.V. set. It consists of a housing enclosing an IR LED emitter with two IR phototransistors located opposite across the drop chamber to register the drops, and an integral interconnect cable.

The LED is pulsed at 2 kHz, at a 12.5 per cent duty cycle. The signals from the phototransistors are demodulated by U46, a quad analog switch, which is used as a synchronous demodulator.

A sudden drop in the output level of either phototransistor causes a negative pulse at the input of differentiator U47B. The pulse is inverted by U47B, and the edges squared by U37C. The DROP signal sets flip-flop U5B, which interrupts the processor on IRQ2.

Installing a sensor pulls up the LED drive line above five volts, switching comparator U47A to its high state. The high Logic State is transferred to the Processor FLOWINStalled line through U37D.

3.2.9.2 NURSE CALL

The Nurse Call consists of a relay closure, with an isolated output stage. The relay output is bi-directional to allow AC signals to be switched, or DC signals of indifferent polarity. The back panel connector contacts used for this function are pins 1 and 4. Refer to Section1 1.4.4 for Staff Call Contact Ratings.
Pump alarms that activate Nurse Call are:

- Air In Line
- Upstream (Proximal) Occlusion
- Downstream (Distal) Occlusion
- Motor Speed Error
- "Plug In" Alarm (Battery Dead)
- Infusion Complete
- Flow Sensor Removed
- Empty Bottle Alarm

3.2.9.3 SERIAL COMMUNICATION INTERFACE

The serial interface is compatible with EIA/RS-232 Serial Communication Interface bus. The serial interface allows Pump status to be monitored and history information access by an external host computer system. Changes in the pump operating status can only be made from the Keypad, not from the serial interface.

The Serial Transmit Data and Receive Data from the Processor are converted to EIA/RS-232 levels for transmission by the Serial Communication Interface, U49. The interface IC contains internal charge pumps to generate +12v and -12v for biasing the transmitter and receiver stages.

The transmit and receive lines exit through the Sensor Interface via J12, to the Serial/Flow Connector, J12A, on the rear panel of the Model 8000.

P/N 44000 REVISION HISTORY Revision: E	
Level Date	Description of revision
P01 2/28/96	Preliminary copy for trial distribution (original 1st issue)
P02 6/10/96	Updated section 1.10.1 "FIX ME" codes
P03 11/11/96	Update sections 1.2, 1.3, 1.4, 1.6, 1.7, 1.11 and tech. drawings.
P04 6/26/97	Update sections 2.6,2.7,2.10,2.11,2.12, 2.13,2.14,2.15,1.11, add ICL 35001, opt541 & opt542.
A 11/3/98	Initial release
B 9/00	Updated to include information for newest software release V3.29
C 10/10/00	Updated to include information for newest software release V3.30.00
D 5/15/01	Updated to include information for newest software release V3.40.00 also updated description of Nursecall.
E 9/01/01	Updated to include information for the newest software release V3.41.00